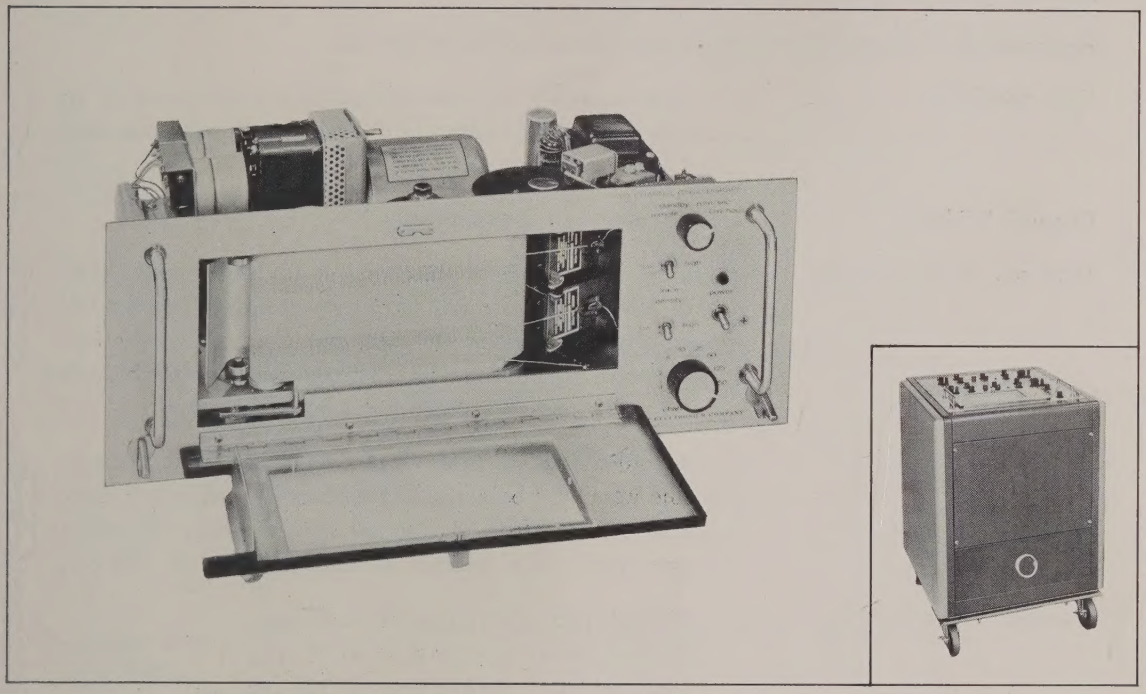
Mattero

BRUSH

OPERATING INSTRUCTIONS

oscillograph
models RD 2622 00
and RD 2722 00

DUAL CHANNEL COMBINATION OSCILLOGRAPH
Models RD 2622 00 and RD 2722 00



Brush Dual Channel Combination Oscillograph, Model RD 2622 00, (Unmounted). Inset—Oscillograph, Model RD 2722 00, and Two Amplifiers, Cart Mounted.

GENERAL INFORMATION

These Brush Direct Writing Combination Oscillographs, Model RD 2622 00, (for rack mounting), and Model RD 2722 00, (for mobile cart mounting), are designed to write with the Brush "RD" series Amplifiers. When matched with these amplifiers, the oscillographs will provide a flat frequency response from d.c. to 100 cps. They are designed for making instantaneous, permanent chart recordings of a wide variety of electrical phenomena. A large hinged cover plate with a window permits reading of seven inches of chart paper as the recording is being made. There is no blind spot since the tips of the pens (or styli) are visible as they are deflected. In either rack or cart mounting, slides provide for partly withdrawing the instrument to facilitate servicing such items as pens, inks, chart paper, etc.

Chart paper speeds of 1, 2, 5, 10, 25, 50, 125, and 250 *millimeters* per *second* are standard. An accessory Slow Speed Motor is available for mounting within the chassis of either oscillograph. It provides additional chart paper speeds in the same multiples but at *centimeters* per *hour*. A complete description of all accessories will be found in Section IV—Supplies and Accessories.

SPECIFICATIONS

The following specifications are applicable to these oscillographs when used with either ink pen, Model RA 2821 30, or with stylus, Model RA 2822 30, for electric writing and when properly matched with Brush amplifiers.

Penmotor	Brush Part No. 425939-501-123.
D.C. Sensitivity	Approximately 30 volts will produce a deflection of 20 mm from chart center (full scale); 1.5 volts per mm; 1.1 ma per mm.
Channel Width	40 mm (40 divisions).
Measured Trace Linearity	d.c.—within 1% of full chart width; a.c.—within 2% of full chart width, any frequency up to 100 cps for ink writing. Deviations are measured from a line through the point of maximum deflection on the chart and through the point of zero voltage and zero deflection.
Frequency Response	Recorded peak to peak amplitude of a constant voltage sine wave will be within ±½ chart line (mm) of nominal 40 lines from d.c. to 10 cps or within ±1 chart line (mm) of a nominal 10 lines from d.c. to 100 cps.
Maximum Amplitude	40 lines (mm) peak to peak, to 40 cps. 20 lines (mm) peak to peak, to 70 cps. 10 lines (mm) peak to peak, to 100 cps.
Chart Speeds	
Standard	1, 2, 5, 10, 25, 50, 125, and 250 mm per second.
Slow Speed Drive	1, 2, 5, 10, 25, 50, 125, and 250 cm per hour.
	Chart speeds may be instantaneously selected by turning a switch on the panel or at remote locations.
D.C. Resistance of Penmotor	1400 ohms.
Operating Temperature Range	32°F to + 135°F (electric writing). 32°F to + 135°F (low temperature ink).
Trace Width	
Ink Writing	0.015 inch with Pen, Model RA 2821 30. Note: Special fine line pen available with trace width of 0.010 inch.
Electric Writing	0.005 inch with Stylus, Model RA 2822 30.
Chart Speed Regulation	Synchronous motor, direct drive.
Paper Drift	Less than ± 1/3 mm.
Power Requirements	105 - 125v, 60 cps, 95 watts at 115v.

Dimensions	Standard 19″ panel, 7″ wide, and 11″ deep.
Net Weight	38 pounds.
Shipping Weight	60 pounds.

A separate carton containing cables, chart paper, pens, ink, etc., accompanies each oscillograph. Shipping Weight —8 pounds.

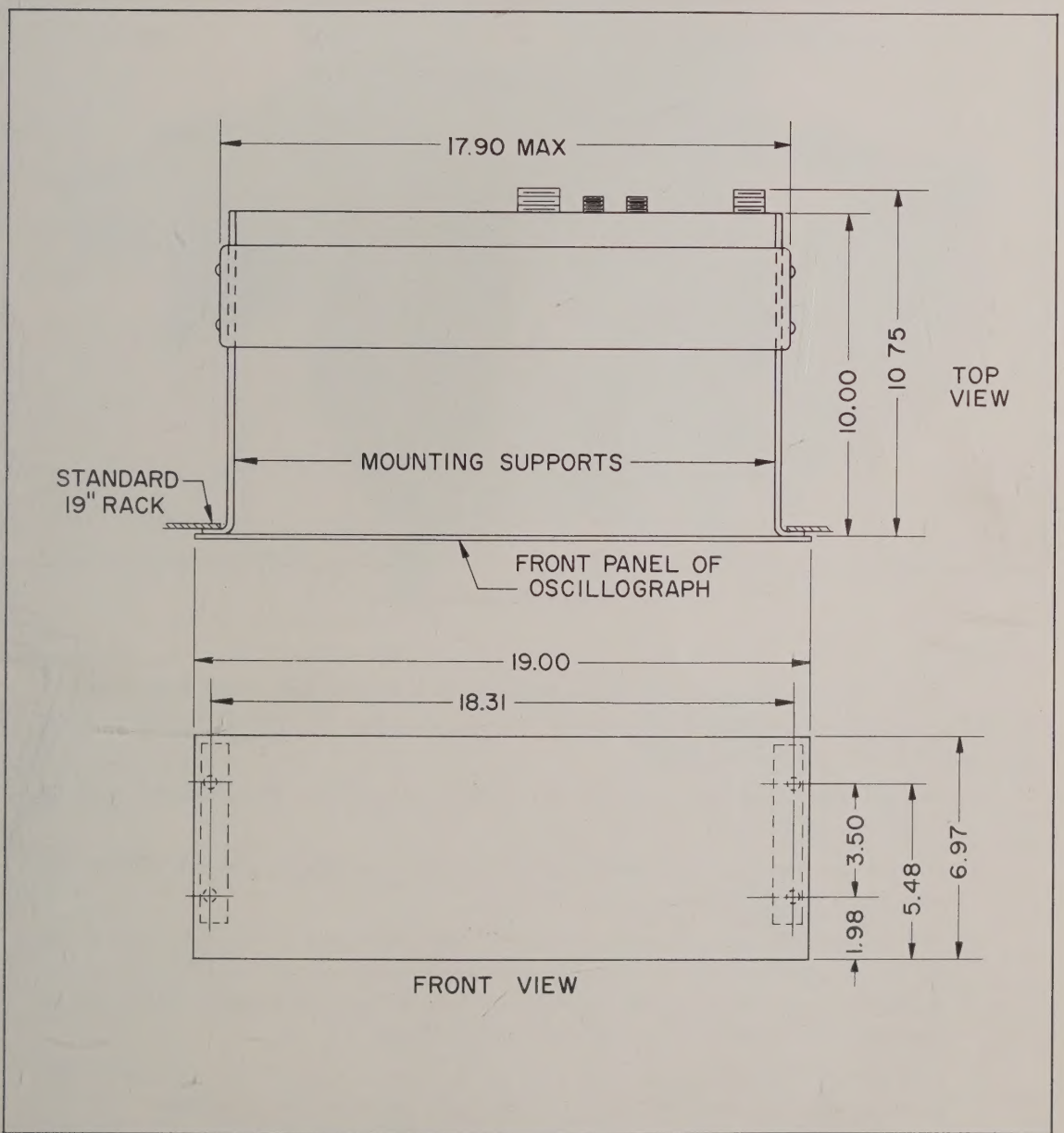


Fig. 1. Dimensional Outline, Brush Oscillographs Models RD 2622 00 and RD 2722 00.

TO INSTALL IN RACK OR CABINET

Rack Mounting Slides (Fig. 1), Brush Part No. 122281-PL1, are furnished for mounting the Oscillograph, Model RD 2622 00, in Brush Cabinets, Models RA 1112 60 and RA 1117 60, or in any standard 19" rack.

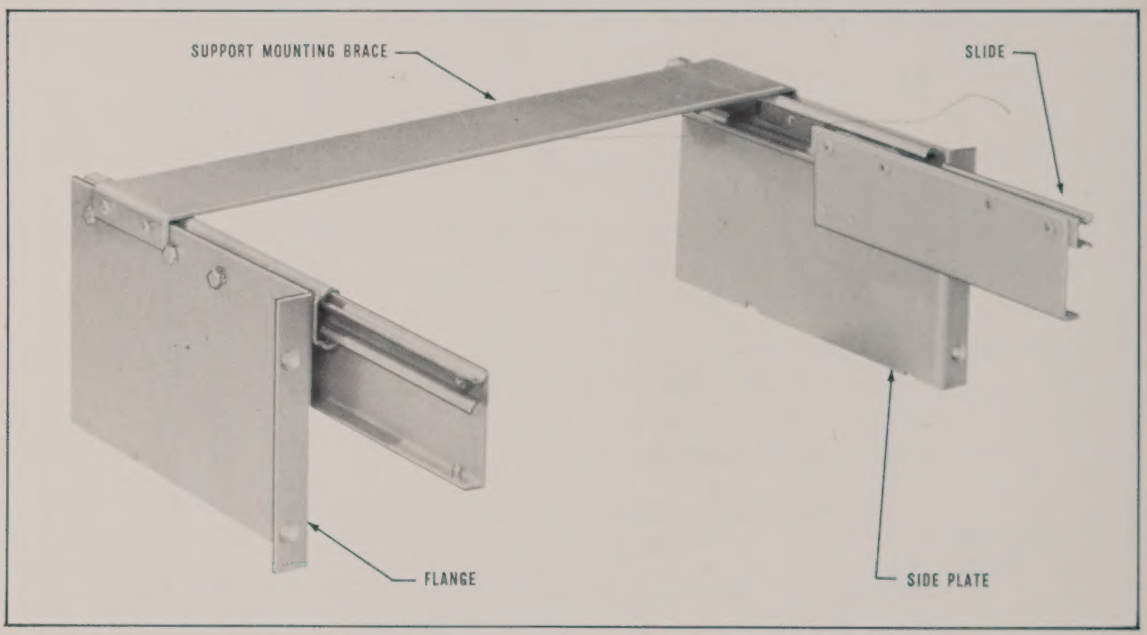


Fig. 2. Brush Rack Mounting Slides.

When the oscillograph is withdrawn from the rack, it may cause a light rack to tip forward. Care should be taken to prevent this tipping. To install the Rack Mounting Slides in a standard rack, proceed as follows:

1. Assemble the SUPPORT MOUNTING BRACE to the SIDE PLATES with the four screws provided. Fig. 1.
2. Position the assembled Rack Mounting Slides in the rack. Secure the FLANGES to the rack with the four flat-head screws furnished.
3. Pull the SLIDES outward to the "servicing" position. Align the formed edges at the top of the oscillograph chassis with the supporting angles on the SLIDES. Move the oscillograph into place on the SLIDES until the locating pin on each SLIDE can be engaged with a locating hole in the oscillograph chassis.
4. Push the oscillograph into the rack until the latches are engaged. To lock the oscillograph in the "operating" position, turn the latch locking levers downward.

CART FOR RECORDING EQUIPMENT
Model BL-817

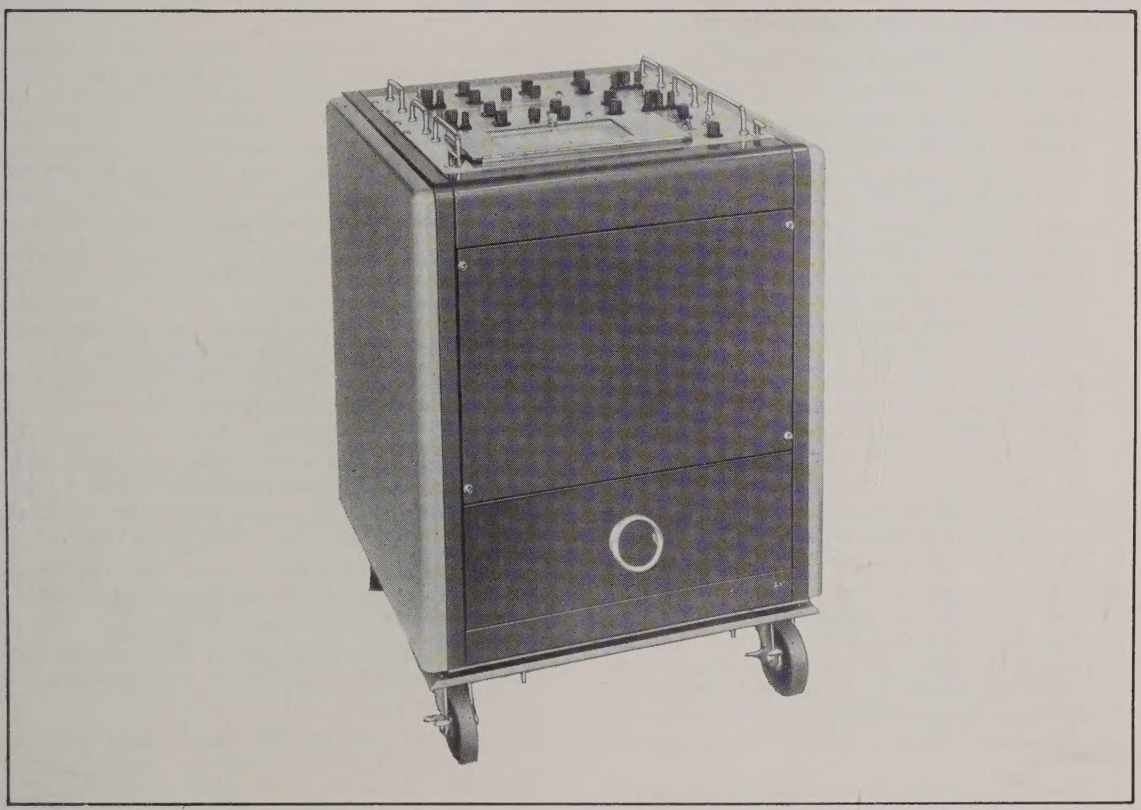


Fig. 1. Brush Cart for Recording Equipment Model BL-817.

The Brush Cart for Recording Equipment Model BL-817 is designed to accommodate one Brush Oscillograph Model BL-261A or Model BL-262A, and one or two Brush 500 series Amplifiers. Fig. 1. A motor-driven fan, mounted to the perforated rear panel of the Cart, assures satisfactory cooling of the Amplifiers. The Cart is shock-mounted to a steel frame which rides on four rubber-tired casters (4″ diameter) for mobility. The two rear casters are of the swivel type; the two front casters are fixed, and equipped with foot-operated locks to secure the Cart in a stationary position when desired. A drawer in the bottom of the Cart provides space for storing tools, accessories, cables, and the like.

A main power input cable (stored on a reel inside the Cart) and a junction box are standard equipment on the Cart. Power cables are supplied as needed for connecting the Oscillograph and the associated Amplifier (or Amplifiers) to the junction box. Cables are furnished for connecting the Amplifier signal outputs with the signal input of the Oscillograph. Self-tapping screws and washers are supplied for securing the Amplifiers and Spring-Loaded Slides (furnished with the Oscillograph) to the rack-type rails in the Cart.

SPECIFICATIONS

Power required	105-125 volts, 60 cps, 170-245 watts, depending on the type and number of Amplifiers used with the Oscillograph.	
Dimensions (overall)	23½″ wide, 32½″ high, 22″ deep.	
Weight	108 pounds	(less recording equipment).
Shipping weight	199 pounds	

INSTALLATION

Special Spring-Loaded Slides are shipped with Model BL-261A or Model BL-262A Oscillographs when the Oscillographs are to be Cart-mounted. Before the Oscillograph is installed in the Cart, the slides must be installed on the Oscillograph.

INSTALLING SLIDES ON OSCILLOGRAPH

To install each Spring-Loaded Slide on the Oscillograph, proceed as follows:

1. Remove the two hex-head screws, with lock washers, from the underside of the slide.
2. Position the supporting angle of the slide under the formed edge at the top of the Oscillograph chassis, then align the screw holes in the slide with the mating screw holes in the Oscillograph chassis. Secure the slide to the Oscillograph by means of a hex-head screw and a lock washer (thread the screw down through the formed edge of the chassis and into the slide).
3. Remove the two nuts, lock washers, and screws securing the slide to the side plate and located at the front, or flange end of the side plate. Loosen the third screw securing the side plate to the slide.

WARNING: *Hold the slide and side plate securely at all times to prevent the coil spring, which is under tension, from leaving its anchor pins.*

4. Carefully move the side plate away from the slide until the coil spring can clear the slide, then move the side plate downward just far enough to allow the second hex-head screw (with lock washer) to be threaded through the Oscillograph chassis and into the slide. See that the screws holding the slide to the oscillograph are secure.
5. Move the side plate into position against the slide once more. Align the screw holes in the side plate with corresponding holes in the slide, then install the two screws, lock washers, and nuts previously removed. Tighten securely the three screws holding the slide to the side plate.

When both slides have been installed on the Oscillograph, secure the support mounting brace to the side plates with the four screws provided.

INSTALLING OSCILLOGRAPH AND AMPLIFIERS IN CART

To install the Oscillograph and its associated Amplifiers in the Cart, proceed as follows:

1. See that the fan cable is disconnected from the junction box. Remove the four self-tapping screws and washers securing the perforated rear panel to the Cart, and remove the panel.

WARNING: *The ventilating fan operates when the fan cable is connected to the junction box, provided the main power cable of the Cart is connected to an appropriate power source. Since the fan blades are unshielded, the main power cable of the Cart must be disconnected from the power source during removal or installation of the Oscillograph, Amplifiers, or the perforated rear panel.*

2. Place the Oscillograph (with slides) in the desired position in the Cart. Noting which holes in the Cart rails are aligned with screw holes in the side rails of the slides, remove the Oscillograph and position four sheet metal nuts on the Cart rails at those holes. Following the general procedure described above, locate sheet metal nuts on the Cart rails for installing Amplifiers.
3. Place a fiber spacer strip (furnished) on each Cart rail, and set the Oscillograph, with its Spring-Loaded Slides, in position in the Cart. Withdraw the Oscillograph to its "servicing" position. (See Operating Instructions for the Oscillograph, ED 31003). Secure the side plates of the slides to the Cart rails with four self-tapping flat-head screws.

NOTE: *In order to make proper use of the sheet metal nuts, the screws should be tightened to 30 pound-inches of torque (draw the screws as tight as possible with a hand screwdriver).*

5. Lower the Oscillograph to its "operating" position, as described in the Operating Instructions for the Oscillograph, ED 31003.
6. Position the Amplifiers in the Cart, securing each Amplifier with four self-tapping screws and washers.
7. Connect each Amplifier signal output connector with a signal input connector on the Oscillograph, by means of the cables provided.
8. Connect the Oscillograph and Amplifiers with the junction box, using the power cables provided.
9. Connect the fan cable to the junction box, then secure the perforated rear panel to the Cart with four self-tapping screws and washers.
10. Connect signal input cables (customer supplied) to the signal input connectors on the front panels of the Amplifiers.
11. Turn the Ink-Off-Electric Switch of the Oscillograph to the "Off" position; turn the Power-Off-On Switch of each Amplifier to "Off". Connect the main power cable of the Cart with the appropriate power source (the cable may be withdrawn approximately 18 feet). For operating procedure, refer to Operating Instructions for the Oscillograph and Operating Instructions for the particular Amplifiers used.

TO INSTALL IN CART

The Brush Cart for Recording Equipment, Model RA 1117 70 is designed to accommodate one Brush Oscillograph, Model RD 2722 00, and one or two Brush "RD" series amplifiers. See insert in frontispiece. A motor-driven fan, mounted to the perforated rear panel of the Cart, assures satisfactory cooling of the amplifiers. The Cart is shock-mounted to a steel frame which rides on four rubber-tired casters (4″ diameter) for mobility. The two rear casters are of the swivel type; the two front casters are fixed, and equipped with foot-operated locks to secure the Cart in a stationary position when desired. A drawer in the bottom of the Cart provides space for storing tools, accessories, cables, and the like.

A main power input cable (stored on a reel inside the Cart) and a junction box are standard equipment on the Cart. Power cables are supplied as needed for connecting the Oscillograph and the associated amplifier (or amplifiers) to the junction box. Cables are furnished for connecting the amplifier signal outputs with the signal input of the Oscillograph. Self-tapping screws and washers are supplied for securing the amplifiers and Cart Mounting Slides to the rack-type rails in the Cart. Before the Oscillograph is installed in the Cart, the slides must be installed on the Oscillograph.

To install each Cart Mounting Slide on the Oscillograph, proceed as follows:

1. Remove the two HEX-HEAD SCREWS, with lock washers, from the underside of the slide.
2. Position the supporting angle of the SLIDE under the formed edge at the top of the Oscillograph chassis, then align the screw holes in the SLIDE with the mating screw holes in the Oscillograph chassis. Secure the SLIDE to the Oscillograph by means of a HEX-HEAD SCREW and a lock washer (thread the screw down through the formed edge of the chassis and into the SLIDE).
3. Remove the two SLIDE MOUNTING SCREWS (Fig. 2) securing the SLIDE to the SIDE PLATE at the front, or flange end of the SIDE PLATE. Loosen the third SLIDE MOUNTING SCREW securing the SIDE PLATE of the SLIDE.

WARNING

Hold the SLIDE and SIDE PLATE securely at all times to prevent the COIL SPRING, which is under tension, from leaving its anchor pins.

4. Carefully move the SIDE PLATE away from the SLIDE until the COIL SPRING can clear the SLIDE, then move the SIDE PLATE downward just far enough to allow the second HEX-HEAD SCREW (with lock washer) to be threaded through the Oscillograph chassis and into the SLIDE. See that the screws holding the SLIDE to the Oscillograph are secure.

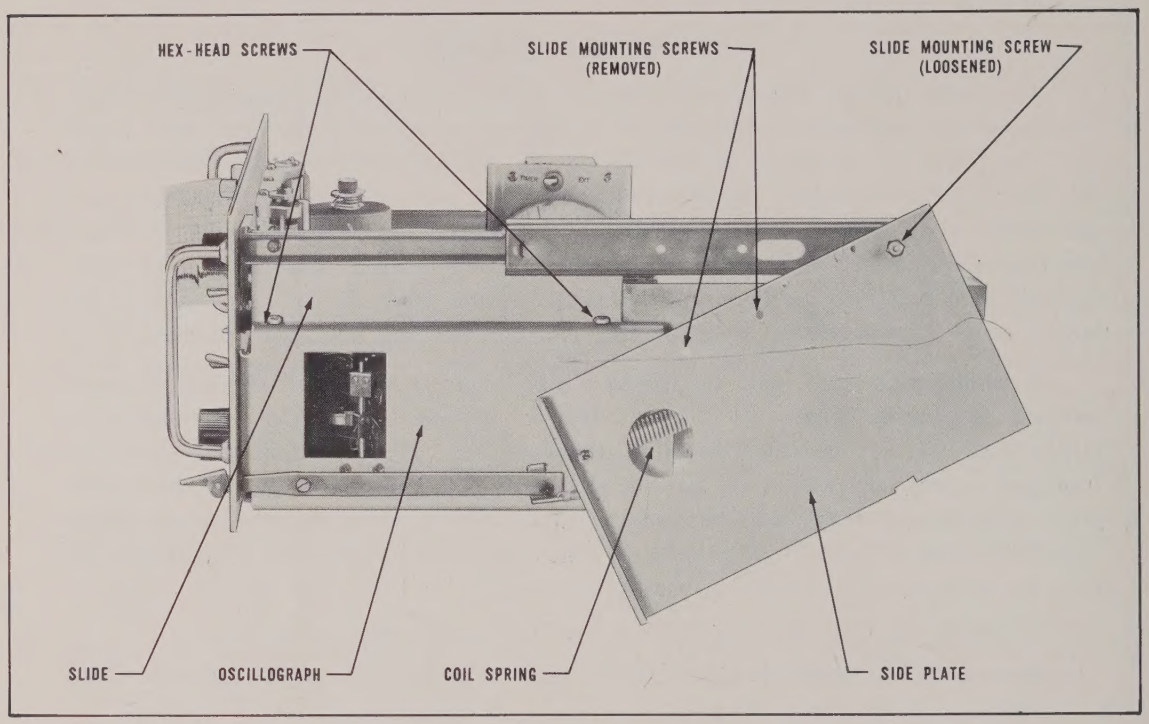


Fig. 3. Brush Cart Mounting Slides.

5. Move the SIDE PLATE into position against the SLIDE once more. Align the screw holes in the SIDE PLATE with corresponding holes in the SLIDE, then install the two screws, lock washers, and nuts previously removed. Tighten securely the three screws holding the SLIDE to the SIDE PLATE.

When both slides have been installed on the Oscillograph, secure the SUPPORT MOUNTING BRACE to the side plates with the four screws provided. Fig. 1.

To install the Oscillograph and its associated amplifiers in the Cart, proceed as follows:

1. See that the fan cable is disconnected from the junction box. Remove the four self-tapping screws and washers securing the perforated rear panel to the Cart, and remove the panel.

WARNING

The ventilating fan operates when the fan cable is connected to the junction box, provided the main power cable of the Cart is connected to an appropriate power source. Since the fan blades are unshielded, the main power cable of the Cart must be disconnected from the power source during removal or installation of the Oscillograph, amplifiers, or the perforated rear panel.

2. Place the Oscillograph (with slides) in the desired position in the Cart. Noting which holes in the Cart rails are aligned with screw holes in the side rails of the slides, remove the Oscillograph and position four sheet metal nuts on the Cart rails at those holes. Following the general procedure described above, locate sheet metal nuts on the Cart rails for installing amplifiers.
3. Place a fiber spacer strip (furnished) on each Cart rail, and set the Oscillograph, with its Cart Mounting Slide, in position in the Cart. Withdraw the Oscillograph to its "servicing" position. Secure the side plates of the slides to the Cart rails with four self-tapping flat-head screws.

NOTE

In order to make proper use of the sheet metal nuts, the screws should be tightened to 30 pound-inches of torque (draw the screws as tight as possible with a hand screwdriver).

4. Lower the Oscillograph to its "operating" position.
5. Position the amplifiers in the Cart, securing each amplifier with four self-tapping screws and washers.
6. Connect each amplifier signal output connector with a signal input connector on the Oscillograph, by means of the cables provided.
7. Connect the Oscillograph and amplifiers with the junction box, using the power cables provided.
8. Connect the fan cable to the junction box, then secure the perforated rear panel to the Cart with four self-tapping screws and washers.
9. Connect signal input cables (customer supplied) to the signal input connectors on the panels of the amplifiers.
10. Turn the POWER Switch of the Oscillograph to the "off" position; turn the POWER Switch of each amplifier to "off". Connect the main power cable of the Cart with the appropriate power source (the cable may be withdrawn approximately 18 feet). Connect the ground lead on the power plug to a ground connection. For operating procedure, refer to Operating Instructions for the Oscillograph and Operating Instructions for the particular amplifiers used.

PREPARATION FOR USE

Both oscillographs are shipped from the factory with ink pens and inkwells mounted. They are also loaded with ink writing chart paper.

TO FILL INKWELLS

To fill INKWELLS proceed as follows:

1. Remove the rubber stopper and by means of medicine dropper (or the dropper supplied with the 2 oz. bottle of Brush ink) fill the INKWELL.
2. Replace the stopper.
3. To start the ink flowing, empty the medicine dropper and insert it tightly in the small breather hole in the top of the stopper. Press a few times on the bulb until the ink begins to flow. The dropper must be held tightly in the stopper to prevent the ink from squirting.
4. The ink will continue to flow by capillary action. Always keep the pen on the chart paper when not in use as this prevents ink from drying in the PEN TIP.

It is recommended that both PENS and INKWELLS be removed and thoroughly cleaned if the oscillograph remains unused for more than three days. It is important to clean the INKWELL because of possible accumulation of sediment in the bottom of the INKWELL, which if allowed to remain may possibly clog the pen. Even though in constant use, it is well to clean the INKWELL occasionally for the same reason. For instructions on cleaning PENS and INKWELLS, refer to Section VI—Maintenance.

TO LOAD OR CHANGE CHART PAPER

To replace chart paper in the oscillograph, proceed as follows:

1. If the unit is mounted in a rack, release the LOCKING LEVERS, one below each pull-out handle on the front panel, by pulling the levers upward. Fig. 4. Maintaining upward pressure on the LOCKING LEVERS, withdraw the oscillograph to its "servicing" position by means of the pull-out handles. If the unit is mounted in a cart, press downward on the pull-out handles while releasing the LOCKING LEVERS, and withdraw the oscillograph to its "servicing" position. Lock the oscillograph in its "servicing" position by releasing the LOCKING LEVERS.
2. Release the LOCKING KNOB on the COVER PLATE, and swing the COVER PLATE away from the front panel of the oscillograph. Fig. 4.
3. Lift the pens or styli by means of the PEN LIFTER. Fig. 5.
4. Move the PRESSURE ROLLER RELEASE LEVER into the released position as indicated in Fig. 5.

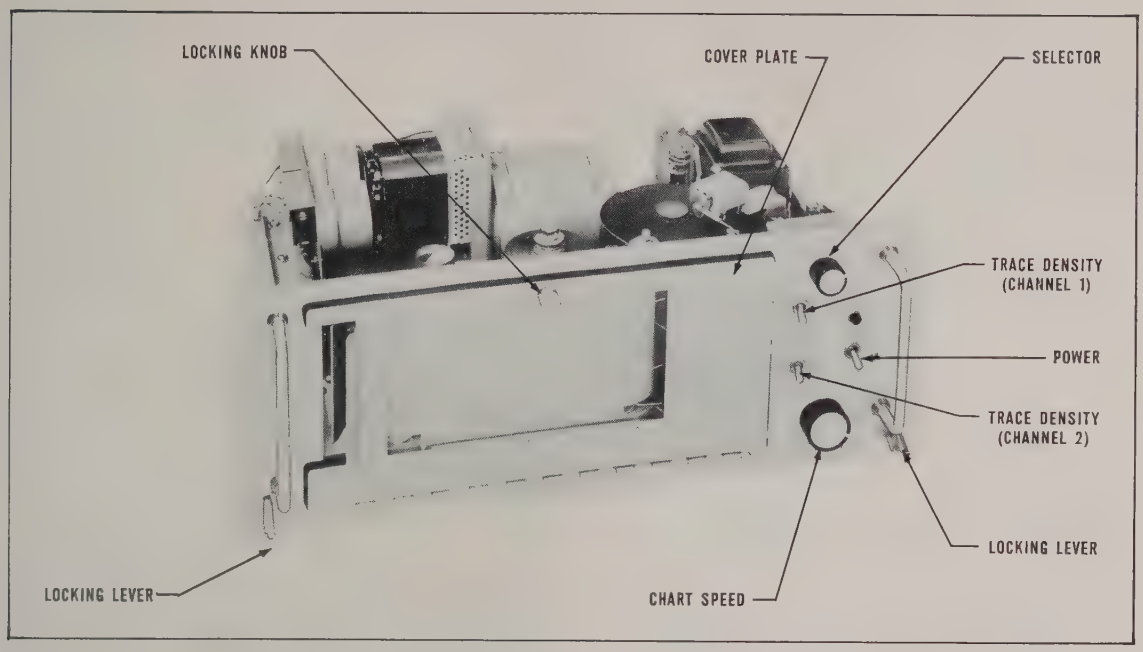


Fig. 4. Brush Dual Channel Oscillograph, Model RD 2622 00 (Unmounted).

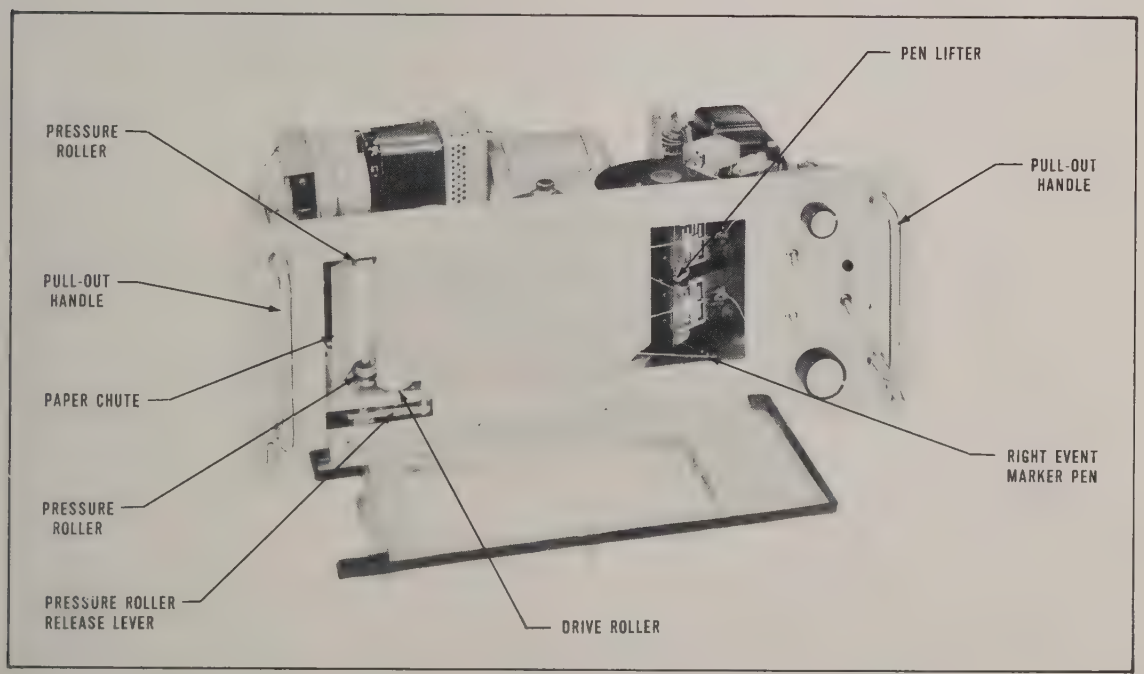


Fig. 5. Brush Dual Channel Oscillograph, Model RD 2622 00, with Cover Plate Open.

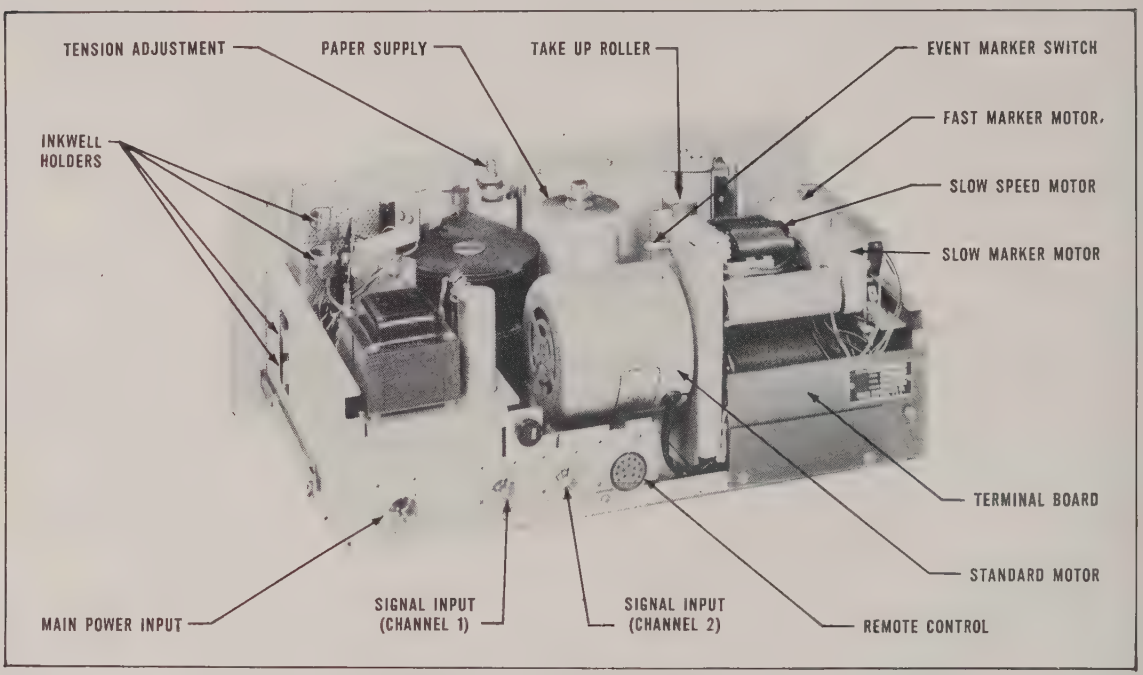


Fig. 6. Back of Brush Dual Channel Oscillograph, Model 2622 00 (Unmounted).

5. Remove the SPRING-LOADED KNURLED NUT from the PAPER SUPPLY spindle. If a paper core from a previous supply is on the PAPER SUPPLY spindle, discard it.

6. Slip the new supply of chart paper over the PAPER SUPPLY spindle.

7. Lock the CHART PAPER on the PAPER SUPPLY spindle by threading the SPRING-LOADED KNURLED NUT into the spindle.

8. Cut the end of the chart paper at an angle of approximately 45°. The point of the chart paper should be on the side away from the chassis deck of the oscillograph. This will facilitate threading the chart paper through the oscillograph and, in the case of internal re-wind, engaging the chart paper with the slots in the TAKE UP ROLLER.

9. Feed the diagonally cut chart paper under the GUIDE BAR and over the paper tension roller and WRITING BAR, as shown in Fig. 7. Thread the chart paper across the WRITING TABLE and over the DRIVE ROLLER, then between the PRESSURE ROLLER and the PAPER CHUTE, as shown by the dotted line.

   Pull out approximately 2 feet of the chart paper. This is necessary as a shorter length may snag (particularly at slow chart paper speeds) and back up into the instrument. This is equally true after tearing off the chart paper by means of the serrated metal strip on the cover plate.

NOTE

These Oscillographs are designed to re-wind 75′ of the 150′ roll of electric writing chart paper, and 150′ of the 300′ roll of ink writing chart paper.

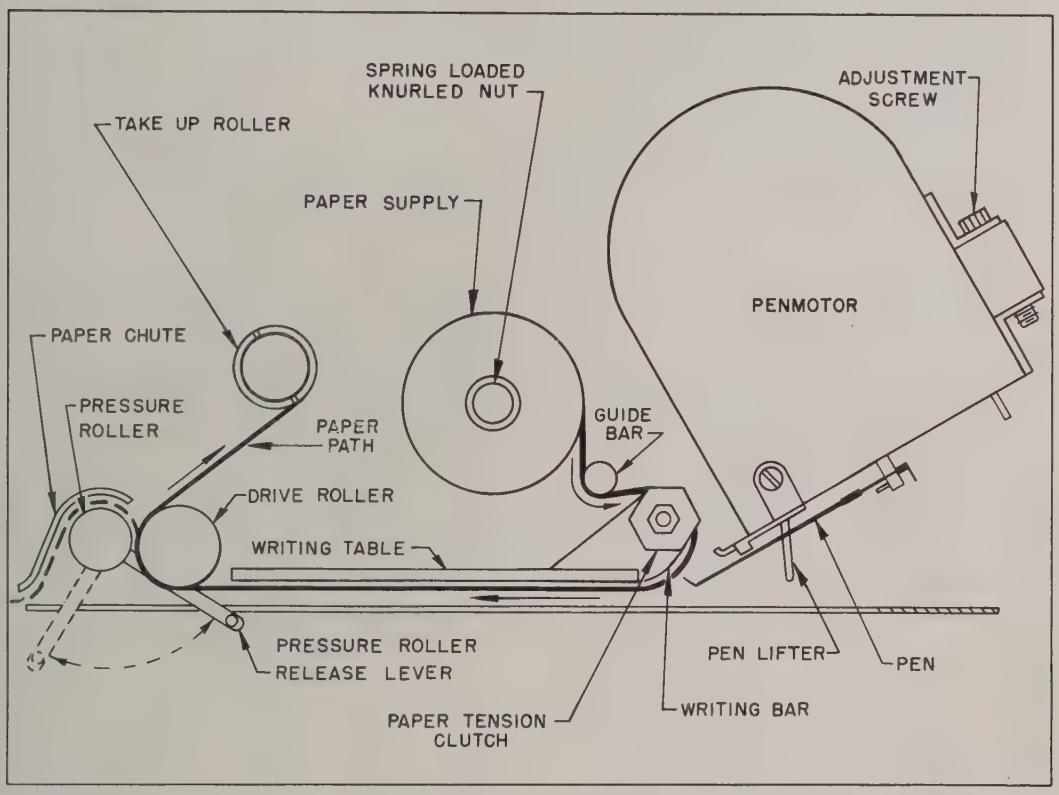


Fig. 7. Paper Loading Diagram.

INTERNAL REWIND

Pass the paper between the DRIVE ROLLER and the PRESSURE ROLLER, then to the TAKE UP ROLLER, as shown in Fig. 7. Insert the diagonal edge of the chart paper in the two opposite slots in the top of the TAKE UP ROLLER. Allow enough slack to permit several complete turns of chart paper around the TAKE UP ROLLER. After aligning and squaring the chart paper, turn the TAKE UP ROLLER by hand, by means of the base disc, to remove the slack from the chart paper.

10. Return the PRESSURE ROLLER RELEASE LEVER to the operating position. Fig. 5.
11. Lower the pens or styli to the chart paper by means of the PEN LIFTER. Fig. 5.

12. Return the COVER PLATE to its closed position, securing it by means of the LOCKING KNOB. Fig. 4.

13. If the unit is mounted in a rack, release the LOCKING LEVERS, one below each pull-out handle on the front panel, by pulling the levers upward. Fig. 4. Maintaining upward pressure on the LOCKING LEVERS, slide the oscillograph inward to its "operating" position, and press the LOCKING LEVERS downward. If the unit is mounted in a cart, release the LOCKING LEVERS and press the unit downward into its "operating" position. Lock the oscillograph in its "operating" position by pressing the LOCKING LEVERS away from the handles.

    To remove chart paper from the TAKE UP ROLLER, cut the paper between the TAKE UP ROLLER and the DRIVE ROLLER and withdraw the accumulated chart paper.

TO REMOVE STYLI OR PENS AND INKWELLS

If it is desired to write with electric styli on Teledeltos chart paper, it will be necessary to remove the PENS and INKWELLS and replace them with electric STYLI. Always turn the oscillograph "off" when removing or mounting styli or pens.

To make this change, proceed as follows:

1. Spread the sides of the PENHOLDER (Fig. 8) with the tips of the Pen Mounting Tool (supplied).

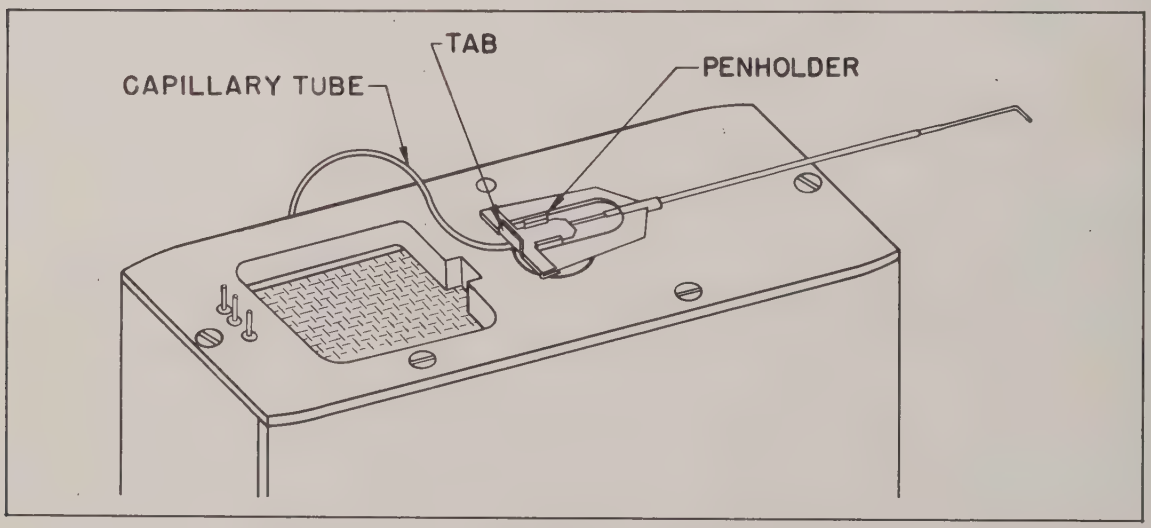


Fig. 8. Diagram of Penmotor and Pen.

2. Slide the PEN from the PENHOLDER. Avoid snagging the PEN TIP while removing the PEN. Fig. 8.
3. While holding the PEN, remove the INKWELL from its holder.
4. Over an expendable surface (old newspapers, etc.) remove the CAPILLARY TUBE from the INKWELL. Do not remove the CAPILLARY TUBE from the PEN.
5. Clean both PENS and INKWELLS before storing, to prevent ink from drying. For instructions on cleaning PENS and INKWELLS, refer to Section VI—Maintenance.
6. After removing pens, store each one in a separate container (tube, envelope, etc.) identified by number with the penmotor from which it was removed. This eliminates re-lapping the pens after remounting.
7. Remove electric styli in the same manner as ink pens.

TO MOUNT PENS

To mount pens proceed as follows:

1. Grasp the SHANK of the PEN between the thumb and forefinger. Fig. 9.

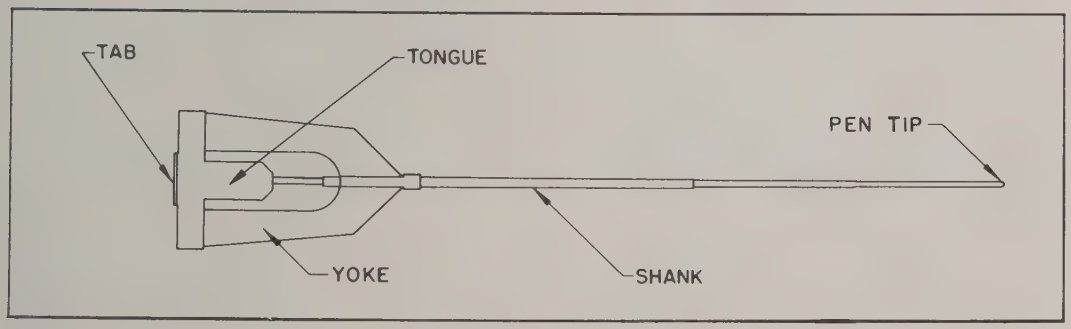


Fig. 9. Diagram of Pen.

2. Place the YOKE of the PEN over the PENHOLDER in such a manner that the PENHOLDER will protrude through the YOKE of the PEN. In this position, the TONGUE of the PEN is behind the penholder.
3. Align the TONGUE of the PEN with the grooves of the PENHOLDER. Fig. 8.
4. Gently spread the sides of the PENHOLDER by means of the Pen Mounting Tool (supplied).
5. With the sides of the PENHOLDER spread, insert the PEN as far as possible. It is important that the PEN be well seated.

6. After removing the Pen Mounting Tool, examine the PEN in the PENHOLDER to determine that the TONGUE is secure and is held in the bottom of the grooves of the PENHOLDER.

7. Lead the CAPILLARY TUBE of the ink PEN to the left side of the penmotor.

8. Slip the CAPILLARY TUBE over the metal tube of the INKWELL.

9. Mount the INKWELL in its holder.

TO MOUNT STYLI

To mount electric styli proceed as follows:

1. Repeat steps 1 through 6, above.

2. Each penmotor is provided with a dual terminal block (for electric writing), located at the top-rear of the penmotors. Plug the leads from the penmotor styli into the two inside holes. The two outside holes are for electric writing event markers.

TO ADJUST PEN OR STYLUS PRESSURE

When new pens or styli are installed, it is important that the tips of the pens or styli apply .5 to .75 gram pressure on the chart paper. This measurement is critical and must be made very accurately. The reading is taken with the hook of the Gram Gage (Brush Part No. 227418-910) under the PEN or stylus at a point 1/32" back of the tip, immediately at the time the tip is lifted from the chart paper. For complete pen pressure information, refer to Section V—Theory of Operation. If the pen or stylus pressure is unsatisfactory, adjust it as follows:

1. If the pressure is too *great,* it may be reduced by lifting the PEN tip (while it is in the PENHOLDER) a few times until the proper pressure is achieved. In electric writing, be sure the oscillograph is turned "off" as the styli carry a high voltage.

2. If the pressure is too *little,* the PEN must be removed from the PENHOLDER before the pressure can be increased.

3. After removing the PEN from the PENHOLDER, grasp the TONGUE-TAB in one hand and the YOKE in the other.

4. Bend the center of the YOKE upward. This changes the plane of the TONGUE in relation to the plane of the YOKE and produces more pressure on the chart paper when the PEN is remounted.

5. Remount the PEN in its PENHOLDER.

6. Re-measure the PEN pressure. It may be necessary to repeat the above steps.

TO ALIGN PENS OR STYLI

To align PEN TIPS proceed as follows:

1. Be sure all PENS are seated in the PENHOLDERS as far as possible.
2. If necessary, the longer of the two pens can be backed-out of the PENHOLDER a slight distance by the use of the Pen Mounting Tool supplied with the instrument. Insert the tips of the Pen Mounting Tool in the PENHOLDER. By gently squeezing the Pen Mounting Tool, the sides of the PENHOLDER can be expanded enough to permit backing-out of the PEN TIP so that it will be aligned with the other PEN TIP. The shorter PEN should always be seated as far as possible in the PENHOLDER.

TO LAP PENS

When installing new ink pens, it is necessary to lap the pens after installation, in order to write uniformly at all frequencies and at all chart paper speeds. To do this, connect the oscillograph to an appropriate power source and to an oscillator, as described in the following sections, then proceed as follows:

1. Release the tension on the PRESSURE ROLLERS. This is to keep the chart paper from moving.
2. Lap the pen tip by operating the penmotor at approximately 60 cps, with the strip of abrasive (supplied with the pen) under the pen tip. Allow ink to flow through the PEN to lubricate the pen tip during the lapping process.
3. Restore tension on the PRESSURE ROLLERS and test for satisfactory pen trace at various frequencies and at all chart paper speeds. Repeat lapping, if necessary.

It is recommended that both the PENS and INKWELLS be removed and thoroughly cleaned if the oscillograph remains unused for more than three days. It is important to clean the INKWELL because of possible accumulation of sediment in the bottom of the INKWELL, which if allowed to remain may possibly clog the PEN. Even though in constant use, it is well to clean the INKWELL occasionally for the same reason. For instructions on cleaning PENS and INKWELLS, refer to Section VI—Maintenance.

PRELIMINARY OPERATION

TO SET UP THE INSTRUMENT

At this point test the instrument in the following manner:

1. Connect the oscillograph to an appropriate power source (105-125v, 60 cps).
2. Turn the SELECTOR switch to "standby".
3. Turn the CHART SPEED switch to "25". Twenty-five millimeters per second is fast enough to align chart paper and slow enough to conserve chart paper.
4. Turn the POWER switch "on". In electric writing, allow 2 to 3 minutes warm-up time.
5. Turn the SELECTOR switch to "mm/sec". This is the operational switch which starts the oscillograph.

6. Test all eight standard speeds momentarily by means of the CHART SPEED switch.
7. Turn the SELECTOR switch to "standby". This stops the oscillograph.
8. Return the CHART SPEED switch to "25".
9. Connect each channel of the oscillograph to a Brush amplifier and an oscillator as explained in the Operating Instructions for the particular amplifier being used.
10. Turn "on" the amplifiers. Allow 15 minutes warm-up time.
11. Adjust each channel of the oscillograph for frequency compensation as explained in the Operating Instructions for the particular Brush amplifiers being used.
12. Turn the SELECTOR switch to "standby". This stops the oscillograph.
13. Turn the POWER switch of the oscillograph "off".
14. Turn "off" the amplifiers and the oscillator.

USE OF ANTI-STATIC SOLUTION

As the chart paper is drawn across the writing table of the oscillograph, static electricity is generated. The plexiglas window in the cover plate, when charged with static electricity, attracts and holds small dust particles. To prevent the collection of dust on the plexiglas window, and thus facilitate reading the chart, the window should be wiped periodically with a cloth containing Brush Anti-Static Solution. A supply of this solution is furnished with the oscillograph; to re-order the solution refer to Section IV—Supplies and Accessories.

TO CONNECT EVENT MARKERS

The Left Event Marker operates in a dual capacity, either to place an event mark on the chart paper by means of a customer supplied, normally open switch, or to place a time pulse on the chart paper working in conjunction with the accessory Slow and Fast Marker Motors. Two leads from the customer supplied switch must be soldered to pins "K" and "R" of the male portion of the 17-pin AN connector which matches the 17-pin female connector on the rear of the oscillograph marked REMOTE CONTROL. Fig. 6.

The Right Event Marker will function only when actuated by means of a customer supplied, normally open switch. Two leads from the customer supplied switch must be soldered to pins "J" and "R" of the male portion of the 17-pin AN connector which matches the 17-pin female connector on the rear of the oscillograph marked REMOTE CONTROL. Fig. 6. For a complete description of the Event Markers refer to Section IV—Accessories.

WARNING

Pin "R" is common to both Event Markers and is connected directly to the main power line, therefore one terminal of each switch is also connected directly to the main power line.

TO CONNECT REMOTE CONTROL

To control the oscillograph from a remote position, connect the instrument as explained above, and proceed as follows:

1. Connect the Remote Control Box to the REMOTE CONTROL connector on the rear panel of the oscillograph (Fig. 6), by means of the cable supplied.
2. Place the Selector Switch of the Remote Control Box in the position marked "off".
3. Place the SELECTOR switch of the oscillograph on position marked "remote".
4. Turn the POWER switch on the oscillograph "on". In electric writing, allow 2 to 3 minutes warm-up time.
5. Turn the Chart Speed Switch on the Remote Control Box to the desired chart paper speed.
6. To *start* the oscillograph, turn the Selector Switch on the Remote Control Box to "mm/sec" or "cm/hour".
7. To *stop* the oscillograph, turn the Selector Switch on the Remote Control Box to position marked "off". This is the operational on-off switch.

OPERATION

Brush oscillographs are designed to operate in connection with Brush amplifiers. Frequency compensation of each amplifier may be adjusted to match the penmotor with which it is used. For frequency compensation procedure, refer to appropriate amplifier Operating Instructions. The circuitry of the amplifier prevents more than 100 volts a.c. (peak to peak) being applied to the penmotors of the oscillographs. If amplifiers other than Brush amplifiers are used, precautionary measures must be employed to prevent more than this voltage being applied to the penmotors of the oscillograph. The performance of Brush oscillographs cannot be guaranteed if used with amplifiers other than Brush amplifiers.

OPERATING SUPPLIES

DESCRIPTION	BRUSH PART NO.
Chart Paper—Ink—300′ long.	RA 2921 30
Chart Paper—Electric—150′ long	RA 2922 10
Red Ink (standard)—Available in 2 oz., 1 pt., and 1 qt. containers. Ink is available in other colors on special order.	
Pen Cleaning Syringe	125160-501
Gram Gage for Adjusting Pen Pressure	227418-910
Pen Mounting Tool	126717
Signal Cable (ordinarily supplied with amplifier)	223385-501
Anti-static Solution	119392

ACCESSORIES

SLOW SPEED MOTOR—Model RA 2102 40

The Slow Speed Motor is a synchronous motor, mounted within the chassis of Oscillographs Models RD 2622 00 and RD 2722 00. The motor is factory installed when purchased with either oscillograph, but may be purchased and installed at a later date, if desired. The Slow Speed Motor is used for special applications where recordings over a long period of time are to be made. This motor drives through the standard motor by means of an overrunning roller-type clutch and provides chart paper speeds of 1, 2, 5, 10, 25, 50, 125, and 250 centimeters per hour in addition to the standard speeds in mm/sec.

EVENT MARKER—LEFT—Model RA 2103 41

The Left Event Marker operates in a dual capacity, either to place an event mark on the chart paper by means of a customer supplied shorting switch or to place a time pulse on the chart paper. The oscillograph is pre-wired to supply 90v, d.c. for this purpose. In the latter case, it operates in connection with the accessory Fast and Slow Marker Motors. An EVENT MARKER SWITCH (Fig. 6) is located on the motor mounting bracket inside the oscillograph. One position "EXT" (external) provides for the connection to the customer supplied, normally open, shorting switch. The other position marked "TIMER" places an accurate time pulse on the left edge of the chart paper. This position operates in conjunction with the SELECTOR switch on the front panel of the oscillograph. Fig. 4. With the EVENT MARKER SWITCH in the "TIMER" position and the SELECTOR switch in the fast or "mm/sec" position, a one second pulse mark is placed outward from the center of the chart paper. This one second pulse requires an accessory FAST MARKER MOTOR. Fig 6.

With the EVENT MARKER SWITCH in the "TIMER" position and the SELECTOR switch in the slow or "cm/hour" position, a six minute pulse mark is placed inward toward the center of the chart paper. This six minute pulse requires an accessory SLOW SPEED MOTOR as well as an accessory SLOW MARKER MOTOR. Fig. 6. This Event Marker will write with either ink pen or electric stylus. It is available in kit form for field installation. Complete Installation Instructions accompany the kit.

EVENT MARKER—RIGHT—Model RA 2103 42

The accessory Right Event Marker (installed only at the factory) operates only when actuated by means of a customer supplied, normally open switch.

FAST AND SLOW MARKER MOTORS—Model RA 2101 10 (fast)—Model RA 2101 20 (slow)

The Fast and Slow Marker Motors drive micro switches designed to open and close the Left Event Marker coil circuit, so that time correlation of the recorded phenomena may be obtained. The Fast Marker Motor operates in connection with the standard motor drive and places a pulse mark on the chart paper at one second intervals. The Slow Marker Motor operates in connection with the accessory Slow Speed Motor and places a pulse mark on the chart paper at six minute intervals. Both Motors are automatically actuated by the SELECTOR switch.

REMOTE CONTROL BOX—Model RA 2403 05

The Remote Control Box provides a means of starting and stopping the oscillograph, as well as changing chart paper speeds, at a position remote from the oscillograph. This Remote Control Box is designed to operate with ink pens or electric styli.

THE PENMOTOR

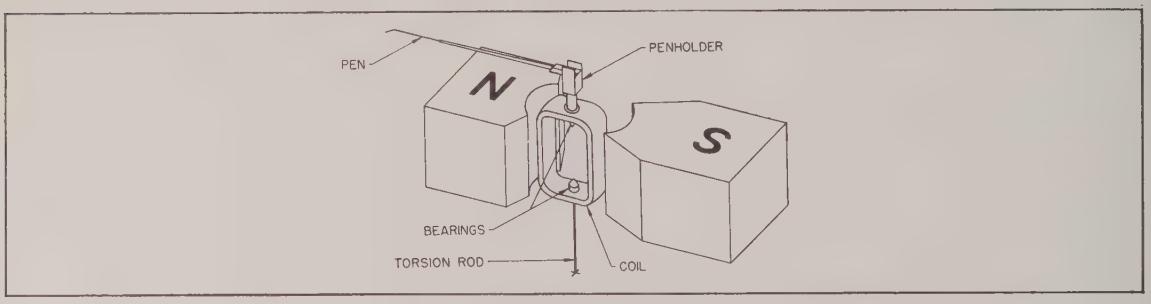


Fig. 10. Simplified Drawing of Penmotor.

The Brush Magnetic Penmotor makes use of the familiar D'Arsonval galvanometer type mechanism in which the coil is used to deflect a pen instead of the conventional mirror.

The penmotor, Figure 10, consists of a coil supported by sapphire jeweled bearings and mounted in the magnetic field of an Alnico V structure. A signal current passing through the coil causes, by motor action, a deflection of the coil about its axis; the deflection in turn causes the movement of the writing pen which is affixed to the coil.

The Brush penmotor differs from the classical galvanometer with its delicate hair springs, in that it makes use of a heavy torsion spring which maintains the zero position of the coil, and also serves the function of holding the coil in its upper bearing by supplying a downward force.

The resonant frequency of the penmotor is established by the stiffness of the torsion spring and the mass of the combined coil and pen assembly. In the subject penmotor the resonance is at a relatively high frequency (about 47 cycles) and the system has the necessary stiffness to maintain a high degree of linearity in the presence of the variable effects of pen tip friction on the writing medium.

The flatness of frequency response with constant voltage input is determined by a number of factors which must be in the proper relationship to obtain the required damping. The mass of the moving system, the stiffness of the torsion spring, the magnetic flux, and the relationship of coil turns and resistance must all be carefully correlated in the penmotor design to obtain critical damping.

Frequency response of the penmotor is flat to 60 per cent of resonant frequency (or about 30 cycles) when the penmotor is properly matched to its driving source.

The penmotors, when driven by the Brush RD series amplifiers operate at about 60 per cent of critical damping which provides the optimum balance between transient response and frequency response. Without compensation the response is flat to about 30 cycles. The Brush RD series amplifiers, in addition to providing optimum damping characteristics, include compensating networks to off-set the decreasing sensitivity of the penmotor above 30 cycles. The compensation adjustment thus can provide a flat response from D.C. to 100 cycles based on a 10 millimeter chart amplitude.

The maximum permissible excursion of the pen is limited at high frequencies by the large forces and velocities inherent in such a system. For example, at 100 cps at the specified maximum amplitude of 10 mm peak to peak, the pen tip velocity is about 3000 mm/sec. Under these conditions the acceleration experienced by the pen tip is about 200 times the acceleration of gravity.

PEN PRESSURE

For optimum writing from d.c. to 100 cps, the pen tip pressure should be adjusted to .625 gram, ±.125 gram. This pressure is light enough to produce accurate recordings in the low frequency range from d.c. to 10 cps, and is high enough to produce very legible writing from 10 to 100 cps. If flat response ±½ chart line (mm) is desired from d.c. to 10 cps at 10 mm peak to peak, it is recommended that .375 gram pen pressure be used. This pressure produces minimum friction and results in improved accuracy of response from d.c. to 10 cps. However, at higher frequencies it is not sufficient pen pressure to prevent hit-skip writing.

If the majority of the recordings are to be made in the range from 10 to 100 cps, a pen pressure of 1.25 grams is recommended. This pressure will write from d.c. to 10 cps, but the high friction involved reduces the linearity of recordings made in this range.

USE OF OSCILLOGRAPH WITH OTHER THAN BRUSH AMPLIFIERS

In using the Brush penmotor with any input other than from Brush amplifiers, precautions must be taken not to exceed a current of 25 milliamperes or 35 volts d.c., or 100 volts a.c. peak to peak.

INK VERSUS ELECTRIC WRITING

There are individual advantages to both ink and electric writing. The method of writing is determined by the type of operation.

Some of the advantages of ink writing are as follows:

1. Better linearity
2. Uniform trace density.
3. Inexpensive ink chart paper.
4. Good reproductions by photography or other reproduction methods using heat or light, such as blueprinting.

Some of the advantages of electric writing are as follows:

1. Unattended operation. This feature is particularly valuable on protracted, unattended operations or where intermittent, unattended operations are necessary.
2. Recording at sub-freezing ambient temperatures.

GENERAL PRECAUTIONS

1. Keep watches, chronometers, and similar instruments away from the oscillograph.
2. Do not drop the oscillograph or tap penmotors with a hammer.
3. Prevent dirt, dust, metal filings, and the like from entering penmotors.
4. If the penmotor becomes damaged, remove it from the oscillograph and send it to the factory for adjustment or replacement. Special equipment is required for magnetization and coil alignment.

TROUBLE SHOOTING

The chart below lists symptoms and probable causes of improper operation of the oscillograph, or failure of the oscillograph, as well as proper remedies for unsatisfactory operation.

The conditions described in the chart are for the Dual Channel Combination Oscillographs Models RD 2622 00 and RD 2722 00, operating from a 105-125v, 60 cps power source. Procedures suggested in the "Remedy" column may be performed by operating personnel.

SYMPTOM	CAUSE	REMEDY
1. Ink pen writes intermittently.	a. Incorrect pen pressure.	a. Refer to section "To Adjust Pen or Stylus Pressure".
	b. Pen tip not fully in contact with paper.	b. Refer to section "To Lap Pens".
	c. Pen improperly seated in penholder slots.	c. Re-seat pen properly.
2. Ink pen will not write.	a. Lack of ink.	a. Fill inkwell.
	b. Pen not primed.	b. Prime pen. Refer to section "To Fill Inkwells".
	c. Pen clogged.	c. Refer to section "To Clean Pens and Inkwells".
3. Electric Stylus writes intermittently or not at all.	a. Excess carbon deposits on stylus.	a. Turn POWER switch "off" and clean stylus.
	b. Incorrect stylus pressure.	b. Refer to section "To Adjust Pen or Stylus Pressure".
	c. Defective flexible lead to stylus.	c. Replace stylus.
	d. TRACE DENSITY switch improperly adjusted.	d. Adjust TRACE DENSITY switch for optimum writing.
	e. Defective rectifier tube.	e. Replace tube.
	f. Filter capacitor "shorted".	f. Replace capacitor.
4. Penmotor inoperative.	a. Lack of proper signal source.	a. Connect to proper signal.
	b. Defective signal cable.	b. Replace or repair cable.
	c. Open penmotor coil.	c. Replace penmotor.
	d. Defective relay.	d. Replace relay.
5. Chart paper drive will not operate.	a. POWER switch not turned "on".	a. Turn POWER switch "on".
	b. SELECTOR switch on "remote" or "standby".	b. Turn SELECTOR switch to "mm/sec" or if equipped with SLOW SPEED MOTOR to "cm/hour".
	c. SELECTOR switch on the cm/hour position and instrument not equipped with SLOW SPEED MOTOR.	c. Turn SELECTOR SWITCH to "mm/sec".
	d. Fuse open.	d. Replace fuse.
	e. Lack of power at source.	e. Connect to proper power source.

SYMPTOM	CAUSE	REMEDY
	f. Defective power cable.	f. Repair or replace power cable.
	g. Defective motor starting capacitor.	g. Replace capacitor.
	h. Defect in transmission; motor is running.	h. Return transmission to factory for repairs.
	i. PRESSURE ROLLERS not in tension.	i. Restore tension by means of PRESSURE ROLLER RELEASE LEVER.
	j. Defective relay.	j. Replace relay.
	k. Defective drive motor.	k. Replace drive motor.
6. Chart paper speed is not as indicated by CHART SPEED switch; does not change properly as CHART SPEED switch is changed.	a. Defective transmission	a. Return transmission to factory for repair.
	b. Defective contacts on CHART SPEED switch.	b. Repair or replace switch.
	c. Defective 90 v. d.c. rectifier.	c. Replace rectifier.
	d. Improper paper tension.	d. Refer to section "To Measure and Adjust Chart Paper Tension".
7. Chart paper speed erratic.	a. PRESSURE ROLLERS not adjusted properly.	a. Refer to section "To Measure and Adjust Chart Paper Tension".
	b. Erratic transmission.	b. Return transmission to factory for repair.
	c. Variation in frequency of power input.	c. Connect to a power line of stable frequency.
8. Excessive paper surge when shifting chart speed.	a. Defective resistor or capacitor in paper surge suppressor.	a. Replace defective component.
9. MARKER MOTORS inoperative.	a. Defective relays or contacts on EVENT MARKER switch.	a. Replace defective component.
	b. Defective MARKER MOTORS.	b. Replace motors.
10. Event Marker inoperative.	a. Improper wiring of keying circuit.	a. Refer to section "To Connect Event Markers".
	b. EVENT MARKER switch in wrong position.	b. Place switch in proper position.
	c. Micro switch on MARKER MOTOR inoperative.	c. Replace switch.
	d. Relay defective.	d. Replace relay.
	e. Open coil on event marker.	e. Replace event marker.
11. Operation of event marker causing transients in amplifier signal circuits.	a. Defective surge suppressor across event marker.	a. Replace surge suppressor.
12. Arc of pen trace does not match areas printed on chart paper.	a. Improper mounting of individual penmotors.	a. Refer to section "To Align Penmotors".

LUBRICATION

Lubricate all moving parts (gears, bearings, etc.) every six months with a good grade of sewing machine oil or the oil supplied with the Brush Inking Kit. Avoid over lubrication.

TO CLEAN PENS AND INKWELLS

Clogged pens can be cleaned with the Brush Pen Cleaning Syringe. The syringe is spring loaded; when the plunger of the syringe is depressed and released, it will return to its original position. To clean a clogged pen, proceed as follows:

1. Remove the PEN and INKWELL from the oscillograph. Fig. 8.
2. Remove the CAPILLARY TUBE from the INKWELL. Do not remove the CAPILLARY TUBE from the PEN. Fig. 8.
3. With the plunger of the syringe depressed, insert the syringe needle into the end of the CAPILLARY TUBE. Continue to hold the plunger depressed.
4. Insert the tip of the PEN (Fig. 9) into a tumbler of room temperature water and release the plunger. The vacuum thus created will tend to draw water from the outside of the PEN into the syringe.

WARNING

The pen tip is tapered inside, and water must enter the pen through the pen tip. Water flowing through the pen in the wrong direction will cause further clogging.

The above procedure may be repeated until water enters the PEN or syringe, when the syringe must be removed from the CAPILLARY TUBE and emptied; the cleaning procedure may then be repeated. If this procedure does not clear the PEN, allow PEN to soak overnight in room temperature water and repeat cleaning procedure.

The INKWELLS (Fig. 8) should be removed from the oscillograph and cleaned periodically to dispose of sediment which collects in the INKWELL. The INKWELLS may be soaked in room temperature water and rinsed thoroughly. The siphon tube in the INKWELL may be rinsed by means of the syringe.

TO MEASURE CHART PAPER TENSION

The oscillograph leaves the factory with a chart paper tension of 24 to 26 ounces. Incorrect chart paper tension results in unsatisfactory recordings. If the tension is too loose, the chart paper will not remain flat on the writing surface. If the tension is too tight, chart paper speed will be reduced and a consequent error in the time factor of the recording will result.

To measure the chart paper tension, proceed in the following manner:

1. Remove the chart paper from between the DRIVE ROLLER and the PRESSURE ROLLER. Fig. 5. Allow the paper to be free on the writing table.
2. Fasten one end of a strip of self-adhering cellophane tape around the hook of a spring scale (customer supplied).
3. Fasten the other end of the tape firmly along the center line of the chart paper.
4. Pull the chart paper by means of the spring scale. As the chart paper unwinds from the PAPER SUPPLY, the scale should indicate from 24 to 26 ounces tension.

TO ADJUST CHART PAPER TENSION

To adjust chart paper tension, proceed as follows:

1. Withdraw the oscillograph to its "servicing" position and open the cover plate. Loosen the lock nut on the PAPER TENSION CLUTCH, holding the adjusting nut of the PAPER TENSION CLUTCH to prevent its turning. Fig. 7.
2. Adjust the paper tension by turning the adjusting nut in the appropriate direction while maintaining tension with the spring scale as described above. (To increase tension, turn the adjusting nut in a clockwise direction; to decrease tension, turn the adjusting nut in a counterclockwise direction.)
3. After establishing the proper tension with the adjusting nut, hold it in exactly the position which provides the desired reading, and tighten the lock nut.
4. Close the cover plate and return the oscillograph to its "operating" position.

TO ALIGN PENMOTORS

Penmotors are factory aligned. The arc struck by the pen must match the printed arc on the chart paper within ±.005" measured at full deflection, to meet factory standards. This is a function of the lateral adjustment of the penmotor.

If it is necessary to re-align one or more penmotors, proceed as follows:

1. Disconnect all cables from the instrument.
2. Place the instrument on a solid work surface at a convenient height. If the oscillograph is rack-mounted, remove it from the rack; if the instrument is cart mounted, remove it from the cart.
3. Loosen *very slightly* the two hex socket head screws securing the penmotor that is to be adjusted to the aluminum support bar. Usually ¼ of a full turn is sufficient.
4. Grasp the penmotor in both hands and move it slightly in the proper direction. Do not tap the penmotor with a hammer or any tool, since this may affect the magnetism.
5. Test the alignment of the penmotors by moving the pens gently, in succession, across the chart paper. The chart paper must be taut on the writing surface.
6. Tighten securely the two hex socket head screws previously loosened.
7. Re-test as in step 5 above. If necessary, repeat the above alignment procedure.
8. Re-connect all cables to the instrument.

EXPLODED VIEW PARTS LIST, Models RD 2622 00 and RD 2722 00

It is recommended that, for major servicing or repairs, the instrument be returned to the factory service stations where facilities are available to restore it to its original condition. In the event that this is impractical or the repair is of a minor nature, the following parts lists and their accompanying exploded views are designed to assist in servicing and repairing. When ordering parts, order by part number and name, not by item number.

ITEM NUMBER	DESCRIPTION	BRUSH PART NUMBER	QUANTITY PER OSCILLOGRAPH RD 2622 00	RD 2722 00
1	Door	321725	0	1
1	Door	322571	1	0
2	Window	221724	1	1
3	Hinge	121723	1	1
4	Door Latch Knob	113401	1	1
5	Door Latch Shaft	121601-501	1	1
6	Lock Lever	122615	2	2
7	Lock Plate	122086	2	2
8	Handle and Ferrule	109584-2	2	2
9	Door Lock	121598	1	1
10	Rotary Switch	2-118980-12	1	1
11	Toggle Switch	121068	1	1
12	Pilot Light	126621	1	1
13	Toggle Switch	121068	1	1
14	Toggle Switch	121068	1	1
15	Rotary Switch	117999	1	1
16	Front Panel	426368	1	1
17	Switch Shield	226561-910	1	1
18	Inkwell Holder	125375-501	0	2
19	Lock Arm Pin	121778	2	2
20	Lock Arm	221782	2	2
21	Left Latch	121780	1	1
22	Lock Arm Spring	121777	2	2
23	Right Latch	121781	1	1
24	Chassis	322072-501	1	1
25	Inkwell Holder	122034-501	1	0
26	Capacitor	20-120142-405	1	1
27	Capacitor Strap	120458	1	1
28	Drive Chain	103526-7	1	1
29	Transmission Sprocket	121021	1	1
30	Marker Motor Mounting Bracket	221092	1	1
31	Transmission Bracket	221097	1	1
32	Shock Mount Bushing	121090	4	4
33	Grommet	1-119054-45	4	4
34	Transmission	216972-501	1	1
35	Relay	122132-501	1	1
36	Terminal Board	222225-501	1	1
37	Capacitor	10-217260-103	1	1
38	Insulator Board	121479	1	1
39	Transmission Spacer	121091	3	3
40	Insulator Board	121921	1	1
41	Terminal Board	121920-501	1	1
42	Capacitor	100-117681-106	3	3
43	Resistor	5-115557-472	3	3
44	Spacer	121922	2	2
45	Motor Gear	121088	1	1
46	Transmission Gear	121095	1	1
47	Switch Shield	122231	1	1
48	Motor Bracket	221099	1	1
49	Toggle Switch	121802	1	1

PARTS LIST (Cont'd)

ITEM NUMBER	DESCRIPTION	BRUSH PART NUMBER	QUANTITY PER OSCILLOGRAPH RD 2622 00	RD 2722 00
50	Drive Motor	319627	1	1
51	Upper Penlifter	125864-501	1	1
52	Lower Penlifter	125866-501	1	1
53	Pen for Ink Writing (Standard)	RA 2821 30	2	2
54	Pen for Ink Writing (Fine Line)	RA 2811 30	0	0
53	Stylus for Electric Writing (Standard)	RA 2822 30	2	2
54	Ink Tubing (3 Ft.)	126270	0	0
55	Penmotor	425939-501-123	2	2
56	Penmotor Mounting Bracket, Rear	113225	2	2
57	Penmotor Mounting Bracket, Front	113226	2	2
58	Penmotor Signal Connector	126001-1	2	2
59	Penmotor Bracket	320593	1	1
60	Stopper	6097	4	4
61	Inkwell	108621-PL1	4	4
62	Inkwell Holder	122039-501	1	0
63	Electric Writing Connector	226940-910	2	2

ACCESSORY LEFT AND RIGHT EVENT MARKERS – RA 2103 41 and RA 2103 42

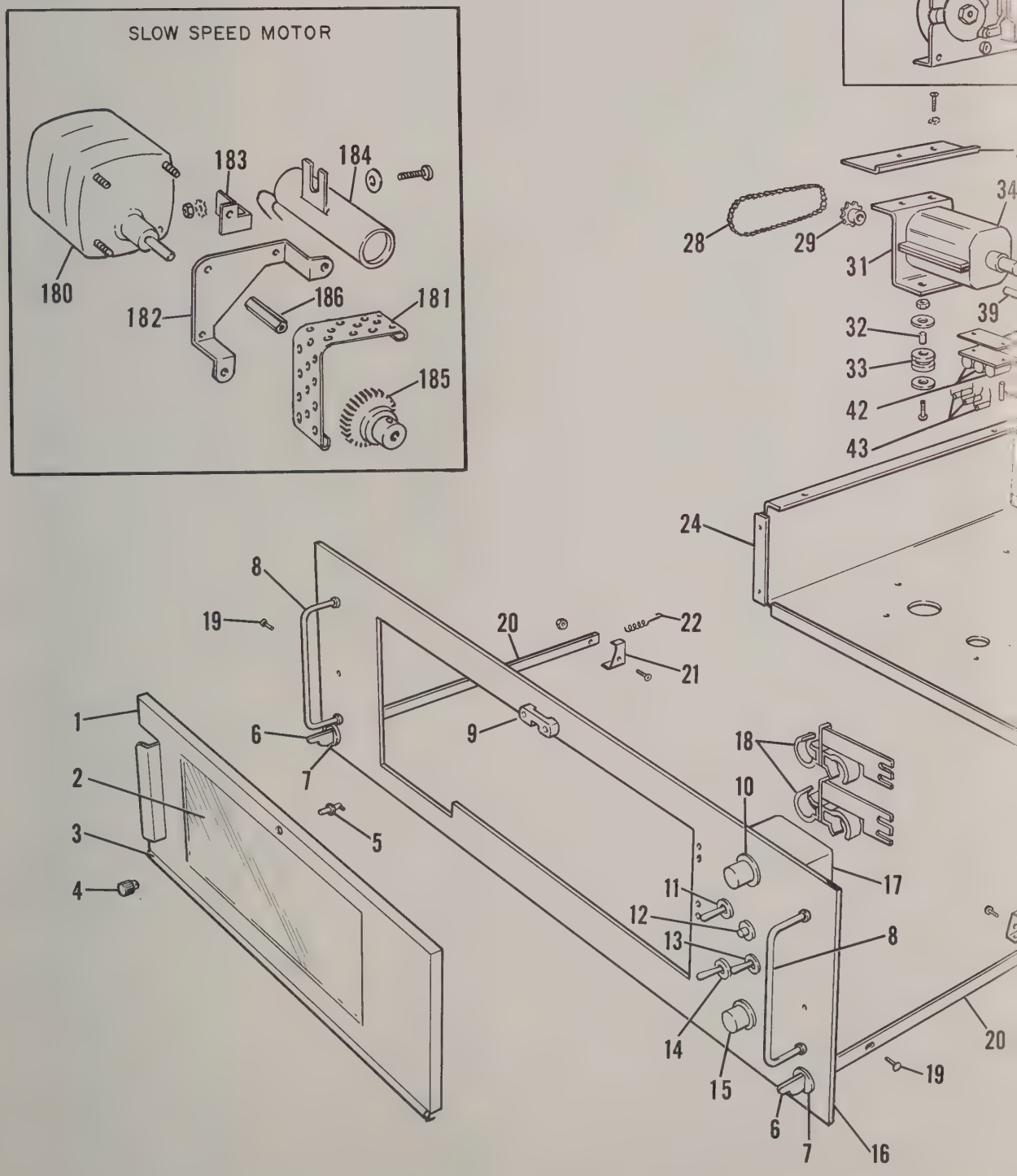
ITEM NUMBER	DESCRIPTION	BRUSH PART NUMBER	QUANTITY PER EVENT MARKER LEFT	RIGHT
170	Penholder and Relay	126273-501	1	0
170	Penholder and Relay	126287-501	0	1
171	Bracket	126611	1	0
171	Bracket	126612	0	1
172	Pen	RA 2871 30	1	1
172	Pen	RA 2872 30	0	0
173	Inkwell	108621-PL1	1	1
174	Stopper	6097	1	1

ACCESSORY SLOW SPEED MOTOR – RA 2102 40

ITEM NUMBER	DESCRIPTION	BRUSH PART NUMBER	QUANTITY PER OSCILLOGRAPH RD 2622 00	RD 2722 00
180	Motor	125233	1	1
181	Cover	221772	1	1
182	Motor Bracket	121530	1	1
183	Capacitor Support	122004	1	1
184	Capacitor and Sleeve	Part of 180	1	1
185	Clutch Gear Assembly	121084-501	1	1
186	Spacer	121529	1	1

ACCESSORY FAST AND SLOW MARKER MOTORS – RA 2101 10 and RA 2101 20

ITEM NUMBER	DESCRIPTION	BRUSH PART NUMBER	QUANTITY PER OSCILLOGRAPH RD 2622 00	RD 2722 00
190	Fast Marker (Motor and Microswitch—One Assembly Only)	RA 2101 10	1	1
190	Slow Marker (Motor and Microswitch—One Assembly Only)	RA 2101 20	1	1


SLOW SPEED MOTOR
MARKER MOTO
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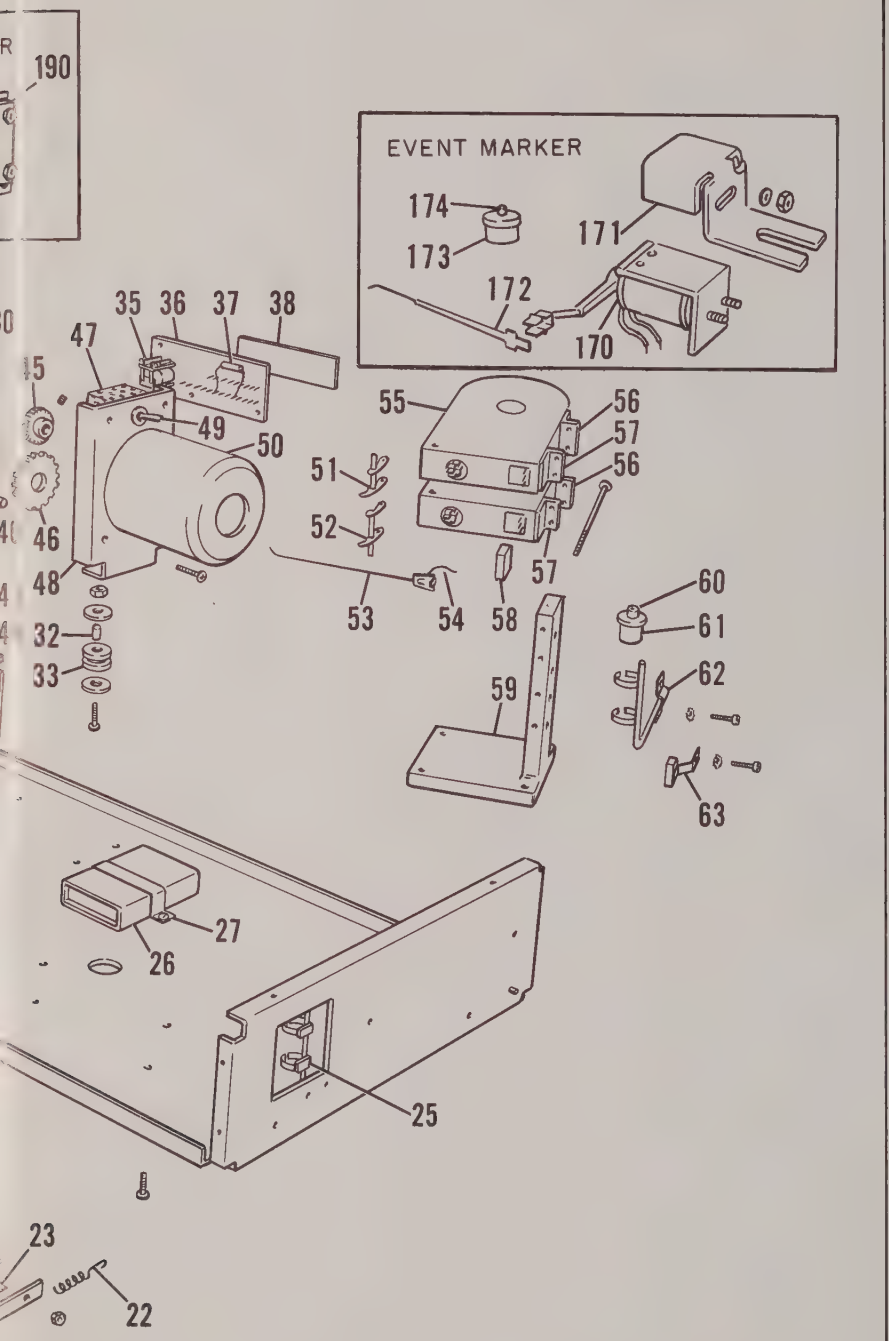
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EVENT MARKER
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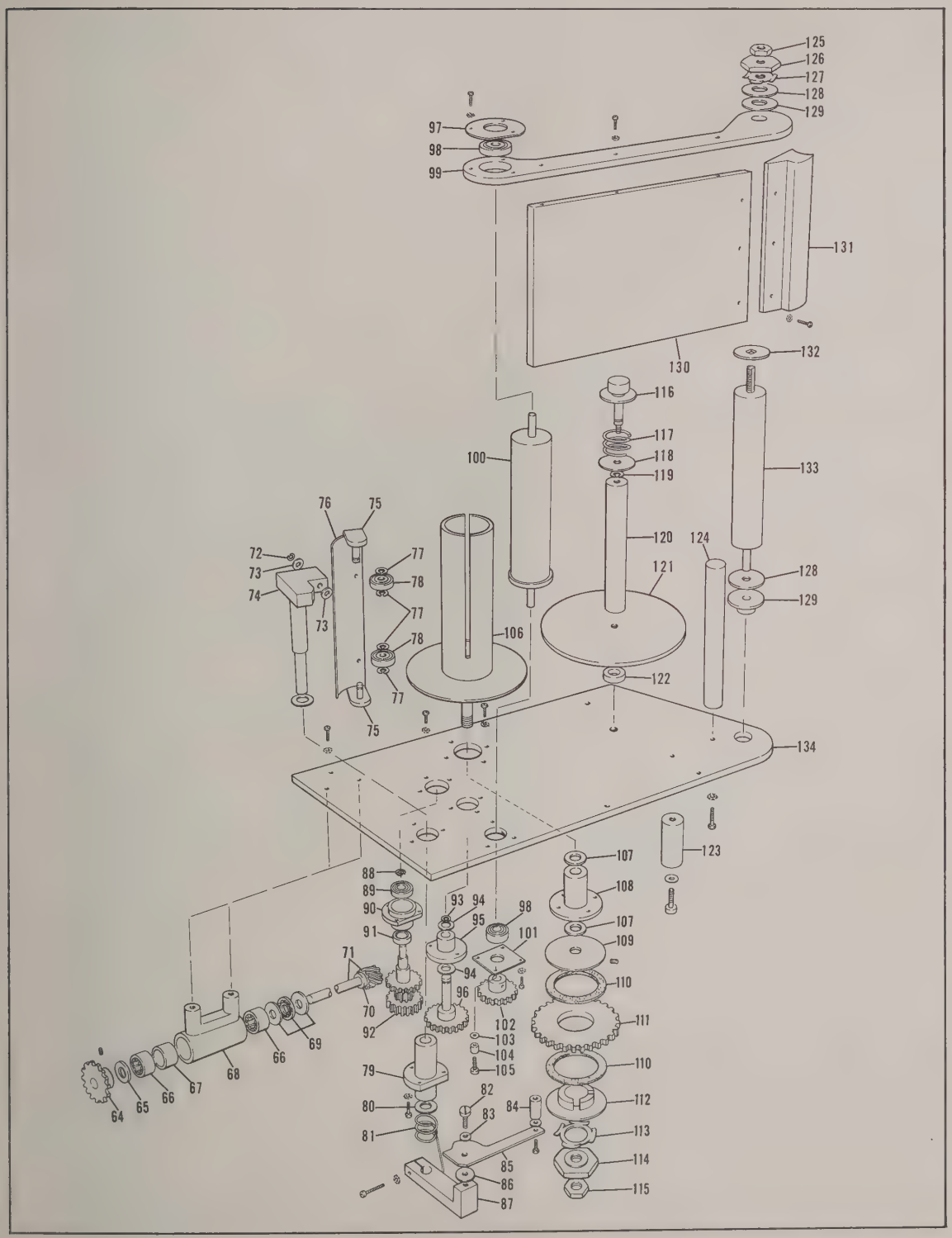
PARTS LIST (Cont'd)

ITEM NUMBER	DESCRIPTION	BRUSH PART NUMBER	QUANTITY PER OSCILLOGRAPH RD 2622 00	RD 2722 00
64	Sprocket	121021	1	1
65	Washer	120961	1	1
66	Drive Shaft Bearing	2-120257-5	2	2
67	Bearing Spacer	123912	1	1
68	Drive Shaft Bearing Block	120939	1	1
69	Drive Shaft Thrust Bearing	123597	1	1
70	Washer	123913	1	1
71	Drive Shaft and Gear	121020-501	1	1
72	Retaining Ring	104307-1	1	1
73	Washer	121017	2	2
74	Pressure Shaft and Pivot	121580-501	1	1
75	Pressure Bracket	121576-501	1	1
76	Paper Chute	121577	1	1
77	Retaining Ring	104307-1	4	4
78	Pressure Bearing	1-210761-1	2	2
79	Pressure Shaft Bearing	120945	1	1
80	Washer	120988	1	1
81	Pressure Release Spring	120997	1	1
82	Screw	120944	1	1
83	Washer	121011	1	1
84	Pressure Release Handle	121391	1	1
85	Pressure Release Cam	221392	1	1
86	Washer	121005	1	1
87	Pressure Release Arm	121004	1	1
88	Retaining Ring	123349-12	1	1
89	Drive Bearing	1-210761-7	1	1
90	Drive Bearing Post	123602	1	1
91	Drive Bearing	1-210761-6	1	1
92	Drive Gear	121010-501	1	1
93	Retaining Ring	104307-6	1	1
94	Washer	120942	2	2
95	Idler Gear Bearing Assembly	227654-910	1	1
96	Idler Gear	121014-501	1	1
97	Upper Bearing Plate	120973	1	1
98	Drive Roll Bearing	1-210761-2	2	2
99	Top Plate	223798	1	1
100	Drive Roll	120971	1	1
101	Lower Bearing Plate	120941	1	1
102	Gear	121015	1	1
103	Washer	121011	1	1
104	Cam Roller	120943	1	1
105	Screw	120944	1	1
106	Take-Up Spindle	120967-501	1	1
107	Washer	120960	2	2
108	Take-Up Bearing	120959	1	1
109	Upper Friction Plate	120968	1	1
110	Take-Up Clutch Disc, Felt	120980	2	2
111	Take-Up Clutch Spur Gear	120983	1	1
112	Lower Friction Plate	120985	1	1
113	Spring	111360-6	1	1
114	Pressure Adjust Disc	120986	1	1
115	Nut	12-119998	1	1
116	Paper Supply Screw	123794	1	1
117	Paper Supply Spring	6513	1	1
118	Paper Supply Washer	123807	1	1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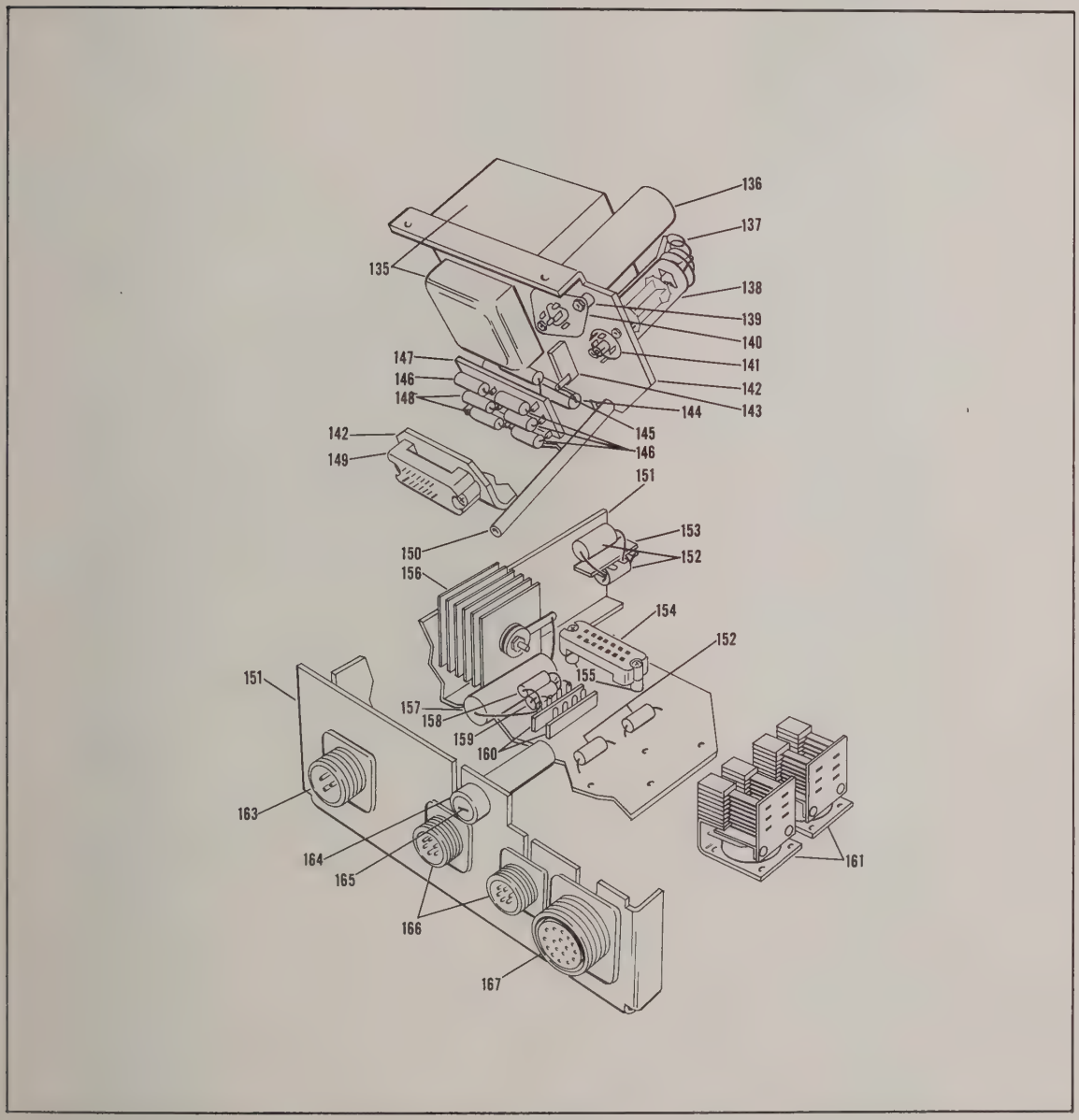
PARTS LIST (Cont'd)

ITEM NUMBER	DESCRIPTION	BRUSH PART NUMBER	QUANTITY PER OSCILLOGRAPH RD 2622 00	RD 2722 00
119	Retaining Ring	1-123349-25	1	1
120	Paper Supply Shaft	123791	1	1
121	Paper Supply Plate	123808	1	1
122	Paper Supply Spacer	123806	1	1
123	Foot	120969	4	4
124	Paper Guide Shaft	123792	1	1
125	Nut	12-119998-02	1	1
126	Nut	123793	1	1
127	Spring	111360-3	1	1
128	Washer	123795	2	2
129	Tension Ball Bushing	123797	2	2
130	Writing Table	220937	1	1
131	Writing Bar	220938	1	1
132	Washer	123796	1	1
133	Tension Roll Shaft	123871-501	1	1
134	Base	323799	1	1
135	Transformer	113128	1	1
136	Capacitor	117717-206	1	1
137	Tube Retainer	109680-2	1	1
138	Tube	117614	1	1
139	Spacer	1-105704-2	2	2
140	Capacitor Mounting Plate	110188	1	1
141	Socket	118948-102	1	1
142	Chassis	321390	1	1
143	Terminal Strip	104099-2	1	1
144	Resistor	10-118180-503	1	1
145	Resistor	10-119370-251	1	1
146	Resistor	10-115559-154	4	4
147	Terminal Board	222226-501	1	1
148	Resistor	10-115559-104	2	2
149	Connector	1-121106-1	1	1
150	Spacer	121766	1	1
151	Chassis	421394	1	1
152	Suppressor	114147-5	4	4
153	Terminal Strip	116858-4	1	1
154	Connector	1-121107-1	1	1
155	Connector Support	121596	2	2
156	Rectifier	111031	1	1
157	Capacitor	100-126067-206	1	1
158	Resistor	5-115559-473	1	1
159	Resistor	5-115559-220	1	1
160	Terminal Strip	104099	2	2
161	Relay	122214	2	2
163	Connector	120283	1	1
164	Fuse Holder	109669	1	1
165	Fuse	102625-9	1	1
166	Connector	120412	2	2
167	Connector	121074	1	1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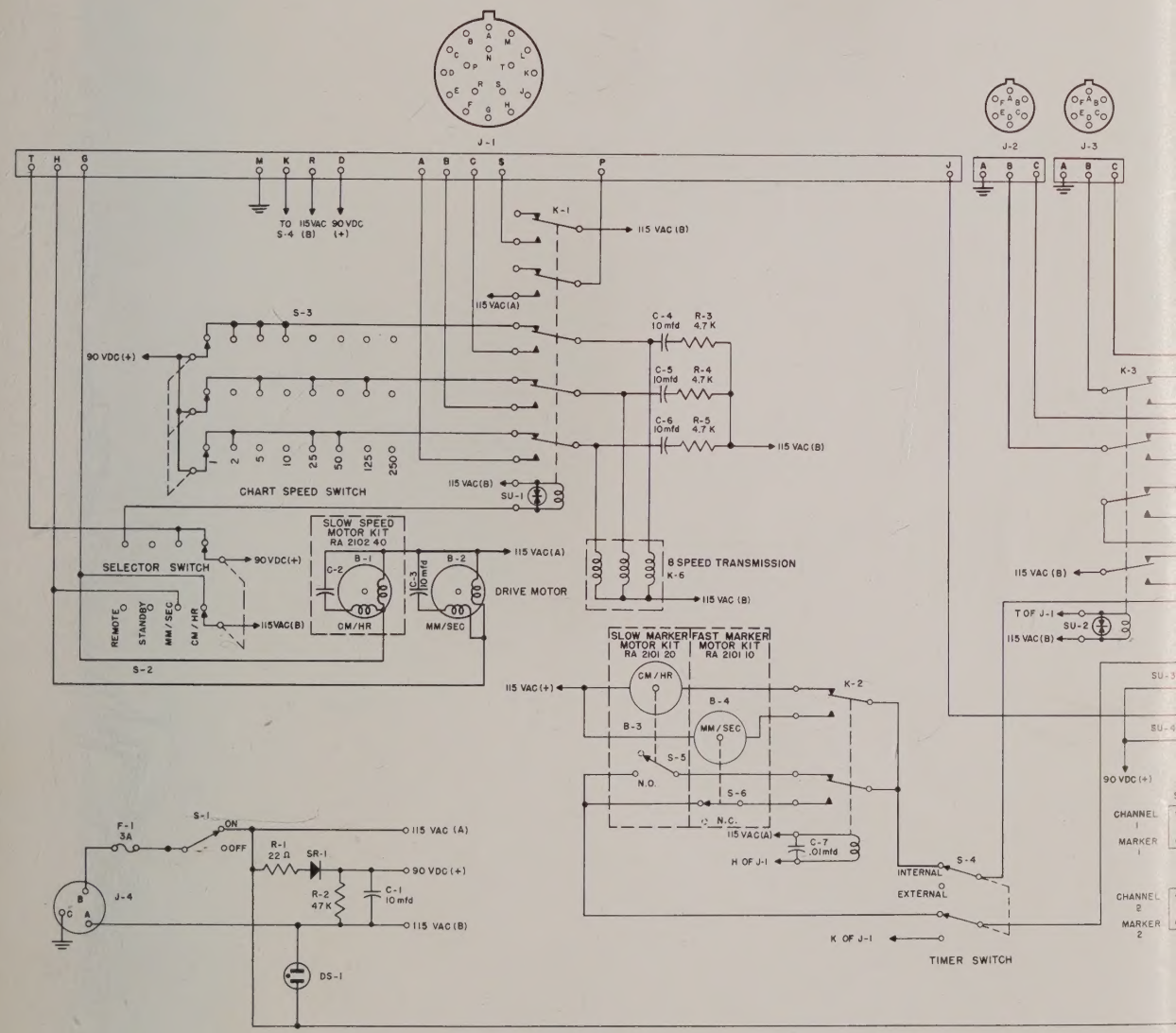
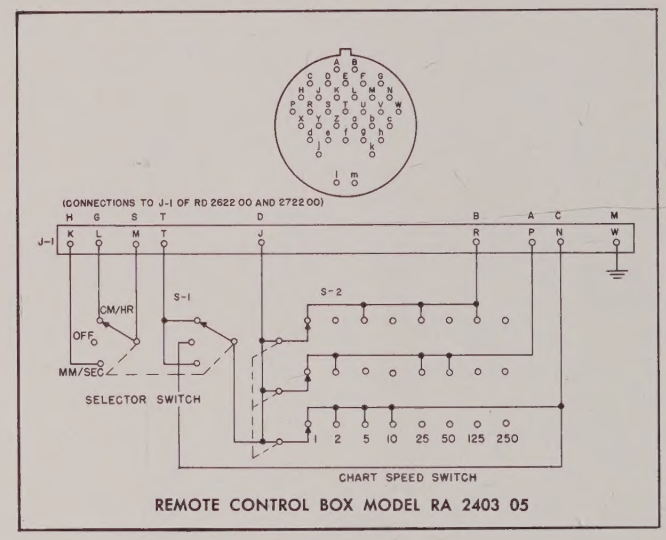
SCHEMATIC PARTS LIST, Models RD 2622 00 and RD 2722 00

SYMBOL	DESCRIPTION	VALUE	BRUSH PART NO.
B-1	Motor, Slow, Includes C-2	Part of RA 2102 40	125233
B-2	Motor, Drive		319627
B-3	Motor, Slow Timing	Part of RA 2101 20	117797
B-4	Motor, Fast Timing	Part of RA 2101 10	117796
C-1	Capacitor, Electrolytic	10 mfd, 150V	100-117681-106
C-2	Capacitor		Part of B-1
C-3	Capacitor, Electrolytic	4 mfd, 220V	20-120142-405
C-4	Capacitor, Electrolytic	10 mfd, 150V	100-117681-106
C-5	Capacitor, Electrolytic	10 mfd, 150V	100-117681-106
C-6	Capacitor, Electrolytic	10 mfd, 150V	100-117681-106
C-7	Capacitor, Electrolytic (½ Double Section)	20 mfd, 450V	117717-206
C-8	Capacitor, Electrolytic (½ Double Section)	20 mfd, 450V	Part of C-7
C-9	Capacitor, Paper	.01 mfd, ± 10%, 600V	10-217260-103
DS-1	Neon Lamp		126621
F-1	Fuse, Type 3AG	3 Amp.	102625-9
J-1	Connector, Receptacle, Female, 17 Pin	AN Type—AN 3102A-20-29S	121074
	Connector Plug, Male, 17 Pin	AN Type—AN 3106A-20-29P	122930
	Cable Clamp (for 17 Pin Connector)		119993-112
J-2	Connector, Receptacle, Male, 6 Pin	AN Type—AN 3102A-14S-6P	120412
J-3	Connector, Receptacle, Male, 6 Pin	AN Type—AN 3102A-14S-6P	120412
J-4	Connector, Receptacle, Male, 3 Pin	AN Type—AN 3102A-16-10P	120283
	Power Cable		223341
J-5	Connector, Receptacle, Female, 14 Pin	Strip Type	1-121107-1
J-6	Connector, Receptacle, Female, 2 Pin		226940-910
J-7	Connector, Receptacle, Female, 2 Pin		226940-910
K-1	Relay, Armature	6PDT	122214
K-2	Relay, Armature	DPDT	5-110243-11
K-3	Relay, Armature	6PDT	122214
K-4	Relay, Marker Coil	Part of RA 2103 41	116832
K-5	Relay, Marker Coil	Part of RA 2103 42	116832
K-6	Transmission, 8 Speed		216972-501
M-1	Penmotor		425939-501-123
M-2	Penmotor		425939-501-123
P-1	Connector, Plug, Male, 14 Pin	Strip Type	1-121106-1
R-1	Resistor, Composition	22 ohm, ± 5%, 2W	5-115559-220
R-2	Resistor, Composition	47K, ± 5%, 2W	5-115559-473
R-3	Resistor, Composition	4.7K, ± 5%, ½W	5-115557-472
R-4	Resistor, Composition	4.7K, ± 5%, ½W	5-115557-472
R-5	Resistor, Composition	4.7K, ± 5%, ½W	5-115557-472
R-8	Resistor, Composition	100K, ± 5%, 2W	5-115559-104
R-9	Resistor, Composition	150K, ± 5%, 2W	5-115559-154
R-10	Resistor, Composition	150K, ± 5%, 2W	5-115559-154
R-11	Resistor, Composition	100K, ± 5%, 2W	5-115559-104
R-12	Resistor, Composition	150K, ± 5%, 2W	5-115559-154
R-13	Resistor, Composition	150K, ± 5%, 2W	5-115559-154
R-14	Resistor, Wire Wound	50K, ± 5%, 10W	5-118180-503
R-15	Resistor, Wire Wound	250 ohm, ± 5%, 5W	5-119370-251
S-1	Switch, Toggle	SPST	121068
S-2	Switch, Rotary		2-118980-12
S-3	Switch, Rotary		117999
S-4	Switch, Toggle	DPDT	121802
S-5	Switch	NO	117813
S-6	Switch	NC	117813
S-7	Switch, Toggle	SPST	121068
S-8	Switch, Toggle	SPST	121068
SR-1	Rectifier, Metallic		111031
SU-1	Suppressor		114147-5
SU-2	Suppressor		114147-5
SU-3	Suppressor		114147-5
SU-4	Suppressor		114147-5
T-2	Transformer, Power		113128
V-1	Tube, Electron	Type 6X4	117614

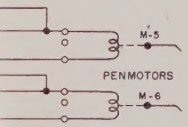
SCHEMATIC PARTS LIST, REMOTE CONTROL BOX Model RA 2403 05

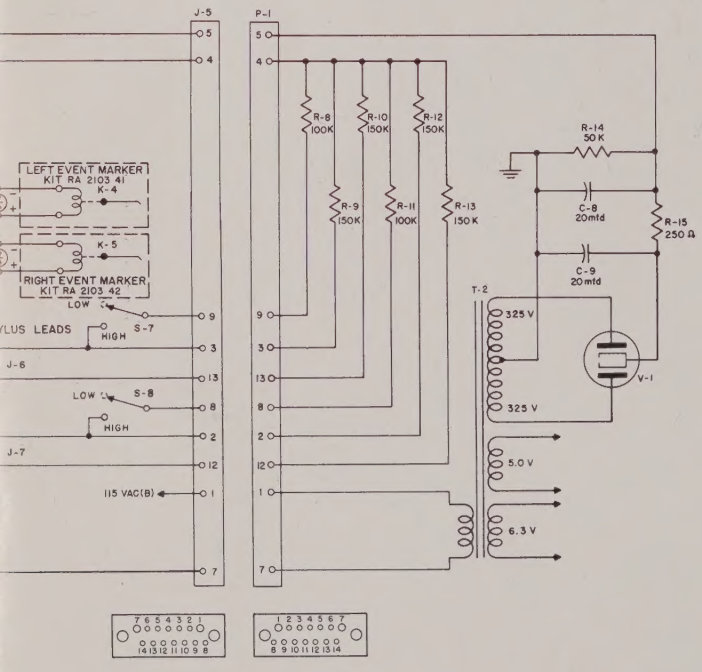
SYMBOL	DESCRIPTION	VALUE	BRUSH PART NO.
J-1	Connector, Receptacle, Male, 35 Pin	AN Type—AN 3102A-28-15P	120407
	Remote Control Cable		222934-501
S-1	Switch, Rotary		120406
S-2	Switch, Rotary		117999

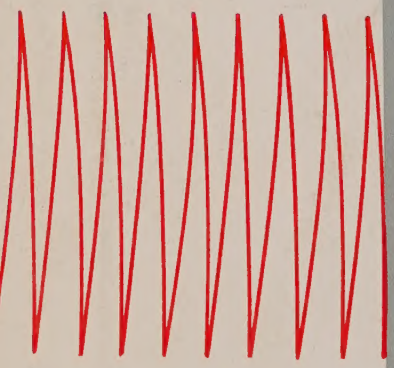

J-1
J-2
J-3
T H G M K R D A B C S P J
TO 115VAC S-4 (B)
90 VDC (+)
K-1
115 VAC (B)
115 VAC (A)
S-3
90 VDC (+)
C-4 10 mfd
R-3 4.7 K
C-5 10mfd
R-4 4.7 K
C-6 10mfd
R-5 4.7 K
115 VAC (B)
1 2 5 10 25 50 125 250
CHART SPEED SWITCH
115 VAC(B)
SU-1
K-3
SLOW SPEED MOTOR KIT RA 2102 40
SELECTOR SWITCH
90 VDC(+)
115VAC(B)
REMOTE
STANDBY
MM/SEC
CM/HR
S-2
B-1
C-2
C-3 10mfd
B-2
CM/HR
MM/SEC
DRIVE MOTOR
115 VAC(A)
8 SPEED TRANSMISSION
K-6
115 VAC (B)
115 VAC (B)
T OF J-1
SU-2
115 VAC(B)
SLOW MARKER MOTOR KIT RA 2101 20
FAST MARKER MOTOR KIT RA 2101 10
CM/HR
MM/SEC
115 VAC(+)
K-2
B-4
B-3
S-5
N.O.
N.C.
S-6
115 VAC(A)
C-7 .01mfd
H OF J-1
INTERNAL
EXTERNAL
S-4
K OF J-1
TIMER SWITCH
90 VDC(+)
CHANNEL 1
MARKER 1
CHANNEL 2
MARKER 2
F-1 3A
S-1
ON
OFF
115 VAC (A)
R-1 22 Ω
SR-1
90 VDC (+)
R-2 47 K
C-1 10 mfd
115 VAC (B)
J-4
DS-1



REMOTE CONTROL BOX MODEL RA 2403 05







brush INSTRUMENTS

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